

SECTION B, PART 0

DIAL TONE TROUBLE CARD ANALYSIS

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B0 DIAL TONE TROUBLE CARD ANALYSIS*

The trouble analysis flowcharts in the A2 Section of the SFD direct the reader to one of the rounded boxes† at the left of SFD-B002 for dial tone marker trouble record cards.

B0-1 CROSS DETECTION: SEQUENCE FAILURE

For either of the double-sided trouble record cards, there is an MXT designation which is punched if there is a cross detected (X-) or if there is a sequence failure (SQA) of the junctor walking circuit. For the single-sided trouble card, there is no MXT punch and it is necessary to scan all of the X- designation and the SQA designation to determine if there is a cross or sequence failure. The reader should proceed through each decision box following Y(YES) if the designation is punched or the statement is true or N(No) if the designation is not punched or the statement is not true. If there is no MXT, cross or sequence failure, the procedure beyond this point is the same for all trouble record cards.

B0-2 WORK TIME OUT

Assume that there was no cross or sequence failure and that the WT designation is punched as an indication of a work time out. If FCG is punched, this is an indication of a cross in the network, which might be anywhere along the path used on the particular call. If there are other FCG cards, several of which indicate use of the same portion of a path such as the same junctor or the same link or a trunk link frame, the probable location of the cross is narrowed.

If the FCG designation is not punched, it is necessary to determine at what point progress in the DTM stopped to cause the work time out. Four key progress points are shown in decision boxes. Analysis should start at the first key progress point which is missing.

* Trouble card analysis is covered at the beginning of each section as a convenience for use in the central office.

† Symbols used in flowcharts are described on SFD-A101.

Assume that the TK designation is not punched. A typical procedure for analysis starting at a missing TK punch will be described. This same general procedure may be adopted starting at HMS1, DCT1, or DIS1 if any of them is the first missing key progress point.

The reader is directed to go to SFD-B003 as described in SCD-B0-2.1.1 and to work up from the first missing key progress designation which in this case is TK. Key progress designations are shown in large heavy letters and are underlined for easy locating.

B0-2.1 TROUBLE ANALYSIS SEQUENCE CHARTS

Sequence charts generally used show a sequence of relay operations with superimposed indications showing trouble record designations which would be present if a record were taken at that point in the sequence.

Trouble analysis sequence charts leave out all of the regular sequence chart except the sequence of the trouble record designations (SFD-A101). A designation with no symbol indicates the point in the sequence at which that designation would be punched if a trouble record were taken. A designation with a triangle (base down) to its right indicates the point in the sequence after which a designation would not be punched.

B0-2.1.1 Use of Trouble Analysis Sequence Chart (SFD-B003)

It was assumed in SCD-B0-2 that the TK key progress point was missing on a trouble card having a WT punch. Start at TK designation on SFD-B003 and work up to the first missing progress designation* required to advance to TK. Assume that HGK, LCK, RK/LK, JCK, and TCHK are all punched, but FAK is not. Proceed up from FAK. Assume that LV2 is not punched and TSE is not punched. TSE should not be punched, but LV2 should. This is the point where DTM marker progress stopped. The LV2 designation is within the block which refers to sequence chart SFD-B004. Proceed to SFD-B004 as described in SCD-B0-2.2.1.

B0-2.2 SEQUENCE CHARTS

The sequence charts used in the SFD follow standard conventions for sequence charts except as noted SFD-A103.

* In some instances, there may be a designation punched such as TSE which occurs early in the call but provides a progress indication by not being punched later in the call.

B0-2.2.1 Use of Sequence Chart (SFD-B004-B006)

It was assumed in SCD-B0-2.1.1 that the LV2, FAK, and TK designations had not been punched but that the LCK was punched and the analysis was that DTM marker progress stopped awaiting the action that would punch the LV2 designation.

The sequence chart SFD-B004 aids in locating the probable cause of the failure. It should be noted from the symbol at the LV2 relay that the LV2 designation is punched from the same source that operates the LV2 relay. Use the relay index to locate the page, for the LV2 and the LC-relay winding of the TL. Both appear on SFD-B421. Since the LC-relay must have operated to cause an LCK punch, the FA-relay, which is required to operate both LC- and LV2, must have operated.

The probable trouble appears then to be in the path that operates the LV2 relay. Before accepting this conclusion, however, consider the following and arrive at a logical answer:

- (1) With these assumptions, could the trouble be an open winding on the LV2 relay?
- (2) Could TRA relay have failed to operate when a trouble record was taken?
- (3) Could an open contact on the TRA relay or an open LV2 lead to the MTFC be the trouble?
- (4) Could the trouble be an open contact on the FA2 relay?

Logical answers are:

- (1) Unlikely unless there are two troubles. An open winding would not prevent punching the LV2 designation.
- (2) No. If TRA relay had failed to operate, there would be no LC-punch.
- (3) Unlikely unless there are two troubles. An open LV2 lead to the MTFC would not have stopped the DTM progress and there would not have been a record.
- (4) Yes. This is a possible cause and quite probable.

B0-3 SDT OR LDT FRAME SEIZURE TIME OUT

If the WT designation is not punched but the SDT or LDT is punched, the DTM is delayed an excessive time while waiting to seize either a line link or a trunk link frame. Normally the SDT (short delay) timer will time out rather than the LDT (long delay) timer. However, if any marker is connected to the trouble recorder or is handling a test call, only the LDT timer is used to allow a longer interval for frame seizure. This is necessary because a marker on test or taking a trouble record holds the frames to which it is connected for the duration of the test call or trouble record. This may delay any other marker which is waiting for the frames being held.

B0-3.1 DELAY IN SEIZING A LINE LINK FRAME

Since the LFK relay causes the SDT and LDT timers to recycle, if there is an LFK punch along with either an SDT or LDT punch, the timers should recycle. However, it is possible that if the LFK should come up just as the timer timed out, the time out SDT or LDT conditions would lock in and the LFK punch could appear along with the SDT or LDT punch.

If LFK is not punched but MAK1 is, this is an indication that the TLC has been seized and has operated its relays (MAK1) but that the line link frame has not been seized (no LFK).

B0-3.2 DELAY IN SEIZING A TRUNK LINK FRAME

If MAK1 is not punched, the interpretation of the CK punch is dependent on whether or not ZL option is provided in the DTM. This option is shown as STD (Standard) option in the operate path of the TFK1 relay (SFD-B204).

If STD option is not provided, absence of the CK punch after an SDT or LDT time out indicates a delay in seizing a TL.

If STD option is provided, the operation of the SDT or LDT relay caused by an SDT or LDT time out operates the TFK1 relay and grounds the CK lead (SFD-B204), so that there will always be a CK punch after an SDT or LDT time out. In this case, the absence of an MAK1 punch with a CK punch indicates a delay in seizing a TL.

B0-4 TRANSFER START

If none of the designations WT, SDT, or LDT are punched and TRS is punched, the record indicates that the LL could not connect to a DTM within the transfer start timing interval and had to transfer its start leads.

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DIAL TONE MARKER INPUT

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B. ESTABLISHING DIALING CONNECTION

When a customer served by a No. 5 Crossbar office removes the receiver, a dial tone will normally be heard concurrently with the receiver reaching the ear. Section B, SFD-10-01 illustrates the steps through which this is accomplished.

Each line in a No. 5 Crossbar office is associated with a line relay which operates when the customer lifts the telephone receiver. The operation of the L relay starts a circuit action which causes the system to establish a connection from the tip and ring of the line through the switching network to an originating register. The originating register provides dial tone to the tip and ring as a signal for the customer to start dialing, then registers the dialed or keyed digits. The sequence of operations in establishing this connection is shown on a sequence chart SFD-B004 through B006. A functional description of these steps follows.

- (B1) In establishing a dial tone connection, a line link frame connects to a dial tone marker via an associated line link marker connector. The LLMC closes through most of those leads required exclusively for the dial tone connection.
- (B2) When a DTM has been seized and has received input information through the LLMC, it proceeds to select a trunk link frame having idle originating registers of the correct type. It then proceeds to select and connect to an OR.
- (B3) After the DTM has seized a TL, it bids for access to the line link originating the call via the associated line link connector. The LLC primarily closes through leads which are required for completing marker functions as well as for DTM functions.
- (B4) When the dial tone marker has identified the calling line location and has selected an originating register, it proceeds to establish a connection through the switching network from the line to the originating register. It also transmits line location and other information to the originating register.
- (B5) Upon completion of the double connection check on heavy traffic or upon completion of both the double connection check and the continuity test on light traffic, the DCT1 relay operates. This starts the release of the marker and cuts dial tone through from the originating register to the calling line.

- (B6) From the A, B, and C dialed digits, it is possible, in most cases, to determine the total number of digits required to be dialed. The OR needs this information so that it can request connection to a completing marker as soon as the required number of digits have been dialed. Determination of this information from the A, B, and C digits is called pretranslation. Pretranslation may be performed within the OR or by pretranslator circuits common to all originating registers.

B1 DIAL TONE MARKER INPUT

B1-1 MARKER SEIZURE

Upon operation of an L relay on a line link frame (SFD-B102) the vertical group start relay (VGS-) of the associated vertical group is operated. This applies a resistance start battery to activate a marker start MSA lead or a marker start MSB lead to start seizure of a dial tone marker. As will be seen later, the Z relay is operated and released on alternate calls so that the MSA and MSB start leads are alternately activated on successive calls. Each line link frame is given preference to one dial tone marker for an MSA start and to another for an MSB start by cross connecting MSA and MSB punchings on SFD-B102 to appropriate MS- punchings on SFD-B103.

B1-2 MARKER CONNECTOR RELAY CHAIN CIRCUITS (SFD-B103)

Three chain circuits are used in selecting a dial tone marker and closing the connector relays between the line link frame and the marker selected. The description of these chains which follows is typical of chains in other types of connectors which will be encountered later.

B1-2.1 CB- (MARKER CONNECTOR BUSY) RELAY CHAIN

An operated CB- relay indicates that the associated marker is busy to the connector. A CB- relay operated for a preferred marker advances the start lead to the next preferred marker. If the CB- relay for that marker is also operated, the start lead is advanced to the next preferred marker, etc.

B1-2.2 MS- (MARKER START OR PREFERENCE) RELAY OPERATE CHAIN

In periods of very light traffic (and assuming no markers busy) MS-relay operation is straightforward. A start signal from a line link frame operates the MS- relay associated with the MS- terminal to which the start lead is cross-connected.

In periods of heavy traffic one or more markers may be busy and two or more line link frames may initiate marker requests either simultaneously or in rapid succession.

Assume that the first and last line link frames (SFD-B102, B103) initiate simultaneous marker requests. Also assume that both start leads are connected to MS0 (that is both prefer marker 0). The MS0 relay associated with each of the two line link frames will operate through the MSK cross-connection to ground in the marker. An early make contact on the MS0 relay for the first line link frame will provide locking ground for that MS0 relay before the break contact on the MS0 relay for the last line link frame opens the MSK ground. Thus both relays will operate and lock.

If, however, the last line link frame initiated a request for a marker slightly ahead of the first line link frame, the MS0 relay for the first frame could not operate. On the other hand, if the first line link frame initiated a marker request first, a subsequent request by the last line link frame could operate the MS0 relay for that frame.

B1-2.3 MS- RELAY WORK CHAIN

Since it is possible to operate two or more MS- relays at the same time, the work chain determines which MS- relay does the work. Ground for the work chain initiates in the marker at the MAK cross-connection. It should be noted that the work chain proceeds through contacts of each MS0 relay in a reverse direction to the preference MSK chain. Contacts on the MS0 relay for the first line link frame are therefore enabled to operate connector relays MA and MB whether or not any other MS0 relay is operated.

Upon operation of the line link marker connector relays MA- and MB-, the MCB- relays of the selected marker are operated over the MB lead. (SFD-B110). The MCB- relays operate CBO relays in every connector having access to that marker (SFD-B103). It should be noted that an operated MA- connector relay contact bridges the break contact of the CBO relay in the start path so that the operated MS0 relay is not released when the associated CBO relay operates.

If two or more MSO relays had operated for different line link frames, the start lead for each of those which failed to get a marker would be advanced to the next preferred marker by operated CBO relays. If, however, no other marker was available, no new MS- relay would operate until some marker became available, at which time one or more MS- relays for that marker would operate. This would continue until all line link frames had been served.

During periods of heavy traffic when all DTMs become busy, a traffic control circuit gates requests by line link frames for DTMs as described in a subsequent section so that all line link frames requesting service are served once before any line link is served a second time.

Relay MS- in operating releases the marker connector check relays MAK, MCK, and MSK (SFD-B103). The release of any one of these relays operates relay TM (SFD-B110), which starts marker timing.

B1-3 W AND Z RELAY CONTROL FOR TRANSFERRING START LEADS (SFD-B102)

If only one start lead is provided, then, under light traffic conditions, a particular connector might seize the same marker for every usage. If this marker is in trouble, all calls from that line link frame might be blocked. To prevent this and also to reduce the adverse effects of other circuit failures, two start leads are provided in each marker connector. By alternating the use of these start leads, two markers serve alternately as first choice markers, thereby providing more even wear on the marker connectors. This transfer is accomplished with a W and Z relay combination. The operation and release of relay Z provides the necessary transfer.

In the following description, assume that relay TRS (transfer start) is normal.

The W and Z relay combination (SFD-B102) operates as follows:

(a) FIRST CONNECTOR USAGE

- (1) Marker seizure - Assume that relays MA- and MB- of the line link marker connector and W and Z of the line link frame are normal. Lead STA has continuity through the break contact of relay Z and lead STB is open. A marker is seized by operation of relay MS- via the MSA to MS- cross-connection. Relay MS- causes the operation of relays MA- and MB-. Relay MA- operates relay MK in the line link frame circuit (SFD-B106), which in turn operates relay W which locks. At this time ground is also applied to both sides of the Z relay to prevent its operation.

- (2) Connector release - When the connector releases, release of the MA- relay releases relay MK which removes the ground which provided the shunt circuit preventing relay Z from operating. Relay Z operates from the locking ground of relay W which remains operated. The operation of relay Z opens start lead STA and closes STB making it available for future usage.

(b) SECOND CONNECTOR USAGE

- (1) Marker Seizure - At this time relays MA- and MB- are normal. Relays W and Z are operated. A marker is seized by the operation of relay MS- via the MSB to the MS- cross-connection. Relay MS- causes relays MA- and MB- to operate. The operation of relay MK, this time, shunts relay W, releasing it. Relay Z remains operated because relay W in releasing transfers the operating ground of relay Z from the locking ground of relay W to the ground furnished by relay MK.
- (2) Connector Release - The release of relay MK when the connector releases removes the Z relay holding ground, allowing it to release. Relay W remains released. The release of relay Z opens lead STB and closes lead STA making it available for the next connector usage. For subsequent usages the actions described above repeat.

B1-4 LINE LINK FRAME TIMING

There are three timers in the link link frame which are normally started whenever a line requests service.

B1-4.1 TRANSFER START TIMER (SFD-B106)

The transfer start timer allows an interval of 0.6 to 1.25 seconds for the LLMC to connect to a DTM (unless all DTMs are busy). If the connection is not established in this time, the line link transfers the start leads and gives a TRS signal to the DTM to cause a trouble record to be taken showing that there was a transfer start condition.

The operation of a VGS- relay operates the DT and TM relays (SFD-B106). The TM relay operates the TMI and also closes through the IM lead from the master traffic control to operate the IM relay. The IM lead will

normally be grounded unless all DTMs are busy, in which case operation of the IM relay is delayed until a DTM becomes idle. The IM relay starts the TRS timer.

The TRS timer continues to time until the DTM has recognized ground on at least one VGT- lead by operation of a VGT- relay which in turn operates the VGR relay (SFD-B108). The VGR relay operates VTK (SFD-B106) which closes through the OC1 and OC2 leads (SFD-B104) to operate the OC1 relay which operates the OC relay. The OC relay grounds the TC and TC1 leads to operate the TC and TC1 relays in the LL. The operated TC and TC1 relays in the LL open the start leads to give the DTM control of the connection and also releases the IM relay (SFD-B106) which stops and recycles the TRS timer.

If a marker is not seized in approximately one second, (providing markers are available as indicated by ground on the IM lead), the TRS tube will fire and operate the TRS relay. The TRS relay opens the start lead in use, closes the alternate one (SFD-B104), releases the TM relay, and holds the TMI relay operated (SFD-B106). The TM relay is released to open the signal leads CWA and TCA to the traffic control circuit to prevent its timing out because of a marker connector trouble. The TM relay also releases the IM relay to recycle the timer (SFD-B106). The TMI relay is held operated to continue the overall timing before a marker is seized. The TRS relay locks operated through the TMI relay. When a marker is obtained over the new start lead, the TMI relay releases upon operation of the MK relay. The TRS relay remains operated over its locking contacts under control of the MK relay. The TRS relay remains operated over its locking contacts under control of the MK relay. The TRS relay transmits to the marker the fact that the transfer has taken place. This information is passed over the TRS lead. The marker causes a trouble record to be taken showing a TRS punch and indicating the LL which encountered the TRS failure. Upon release of the marker, the MK relay, in releasing, will release the TRS relay.

B1-4.2 OVERALL TIMER

An overall timing circuit is provided which sounds the major alarm if a line link calling for a marker has not been connected to one within 4.8 to 10 seconds. It functions as follows: Upon the start of a call, operation of a VGS- relay operates the TM relay at the same time that battery is connected to the start leads for marker seizure. The TM relay operates the TMI relay which starts the overall TM timer (SFD-B106).

For normal operation, a marker is seized before the timing interval has elapsed. This is indicated by the operation of the MK relay from the operated marker multicontact connector relays in line link marker connector circuit. The MK relay releases the TM and TMI relays. During

the releasing time of the TM and TM1 relays, the TM tube timer circuit is recycled by discharging the A capacitor through the C resistance. The TM1 relay normal with the MK relay operated restarts the A capacitor charging circuit to time the release by the marker. If the marker releases the connector within the timing interval, the TM tube will not break down. However, should the marker exceed this time because of some trouble condition or should the marker connector relays remain operated due to a trouble, the TM tube will fire, operating the CA relay which brings in the major alarm and causes the LLMC- lamp at the JLK to remain lighted. This lamp normally flashes on each time the MK relay operates as an in-use indication for the LLMC. When it remains steadily lighted, it serves as an LLMC alarm indication.

The MK relay releases at the end of the call, upon release of the line link marker connector circuit multicontact relays, and discharges the A capacitor to recycle the TM timer for the next call.

B1-4.3 CALLS WAITING TIMING

When a VGS- relay operates on the LL, it operates the DT relay (SFD-B106) which starts the calls waiting timer which has a timing interval of 5.4 to 8.0 seconds. If calls are initiated on a LL at a faster rate than they can be handled so that VGS- relays on an overlap basis supply ground to the D relay (the D relay does not release within the calls waiting timing interval), the CWT relay operates.

The sole purpose of the calls waiting timer is to light a G lamp at the line overload panel for each LL as an indication when calls are waiting an excessive time to be handled by that LL (SFD-B112).

B1-5 DETERMINATION OF REGISTER GROUP

The marker may be equipped to handle one, two, or up to six register groups. The "register group" relays (D, MF, RO-3) actually are associated with different routes, which may contain different types of registers or may contain trunks, such as announcement trunks.

Operation of the MS- relay of the LLMC preference control extends ground to the MC- lead associated with the particular LL and to the associated 2LF- cross-connection terminal in the selected marker (SFD-B104,B105). Cross-connections from these terminals determine the register group.

B1-5.1 MARKER EQUIPPED FOR ONE REGISTER GROUP (SFD-B105)

When the marker is equipped for only one register group, the 2LF- terminals are cross-connected to the LFD terminal to operate the D register group relay.

B1-5.2 MARKER EQUIPPED FOR TWO REGISTER GROUPS (SFD-B105)

If all of the lines on a LL require connection to the same type of register, the corresponding 2LF- terminal is cross-connected directly to the LFD or LFMF terminal to operate the D or MF relay (SFD-B105).

If some lines on a LL require one kind of register and other lines on the same LL require a different kind of register, the corresponding 2LF-terminal is cross-connected to the LFM terminal. Ground on the LFM terminal operates the MLF relay.

Operation of the MLF relay indicates that the LL requiring service is a mixed line frame. When the LL is a mixed frame, the D or MF and associated relays operate after the vertical group is selected with the MLF relay operated. For a mixed frame, the vertical group which is selected will identify the type of register required by the customer.

B1-5.3 MARKER EQUIPPED FOR UP TO SIX REGISTER GROUPS (SFD-B105)

If all of the lines on a LL require connection to the same type of register, the corresponding 2LF- terminal is cross-connected directly to the LFD, LFMF, or LFR- terminal to operate the D, MF or R- relay.

B1-5.4 REGISTER GROUP SELECTION

Three typical cross-connections are shown on SFD-B105 for different types of control of register group selections.

The heavy dashed cross-connections are for line link frames on which all lines use the same type of originating register. Ground on the 2LF lead for one line link frame directly operates the MF relay to direct the selection of a TOUCH-TONE® type originating register. Another line link frame directly operates the D relay to direct the selection of a dial pulse originating register. A third line link frame directly operates the RO relay. This route relay could be assigned to a second group of TOUCH-TONE or dial pulse originating registers. This third illustration would be only for offices having more than two originating register groups (option B provided).

The lightweight long dashed cross-connections are for line link frames on which some lines require dial pulse registers and some require TOUCH-TONE registers, and only two register groups are provided for the office (option A.) Lines requiring TOUCH-TONE originating registers are shown as assigned to vertical group 0-7 while lines requiring dial pulse lines are shown as assigned to vertical group 8. Later in the progress of setting up the connection, if the call had originated in any of the vertical groups 0-7, operation of a relay VGT0-7 would cause the MF relay to operate. However, if the call had originated in vertical group 8, the VGT8 relay operating would operate the D relay.

The lightweight short dashed line cross-connections are only for offices having more than two originating register groups (B option provided). Ground via the 2LF- punching directly operates the VP1 relay. Later in the progress of setting up the connection, if the VGT8 or VGT9 relay operates, the R1 route relay operates. If the VGT10 or VGT11 relay operates, the R2 route relay operates.

A marker will not normally be equipped for more than two register groups. (See Note 400, Parts 2 and 3 of SD-26000-01 for more detailed cross-connection data.)

B1-5.5 FCD-, FCM-, AND FCR- RELAYS

The operation of the D, MF, or R- relay operates the corresponding FCD-, FCM-, or FCR- relays (SFD-B105). Operation of a VP- or an R- relay causes the MLF relay to operate. Operation of the above relays initiates the operations necessary for the identification of the calling line and for the selection of an originating register.

B1-5.6 OPERATION OF THE CKG1,2, GC, GCA, GTL1,2, LLC1,2, ONX, RCY, TLC, AND BX RELAYS

To provide a large number of off-normal grounds and battery potentials to the marker circuit and to interconnect certain functional units, the CKG1,2; GTL1,2; LLC1,2; RYC; and TLC relays will be operated.

The operation of the LLMC MA- relay will extend ground to the CKG lead and will operate the CKG1,2 relays in the marker (SFD-B104). The CKG1,2 relays provide off-normal grounds.

The operation of the CKG1 relay will operate the GTL1 relay, which in turn will operate the GTL2 relay (SFD-B428). The GTL1 and GTL2 relays provide means for transmitting ground supply for the operation of the customer line identification and class-of-service memory relays in the originating register. The GTL1 relay also provides means to connect the frame number identification relays to the LLMC (SFD-B107).

The CKG1 relay in operating will operate the BX relay (SFD-B207) and ONX relay (SFD-B425). The BX relay provides bias for some of the cross-detecting relays, while the ONX relay provides means for testing for crosses on the select magnet leads.

The operation of the D, MF, MLF, or CKG1 relay will operate the TLC relay (SFD-B204). (MLF may be operated by an R- or VP- relay.) The TLC relay provides battery potential for operating the trunk link connector cut-through relays and other miscellaneous off-normal ground and battery functions.

The RYC relay will be operated when the D, MF, or MLF relay operates (SFD-B204). The RYC relay provides some off-normal grounds and is used for recycle control.

The operation of the RYC relay will operate the LLC1,2 relays (SFD-B205). The LLC1,2 relays provide battery potential for seizing the line link frame and operating the line link connector cut-through relays. The LLC1,2 relays also provide other miscellaneous grounds and batteries.

The operation of the LLC1 relay will operate the GC or, if provided, GCA relays which provide junctor group control functions (SFD-B415).

The standing cross test STX relay will be operated when the marker goes off-normal to remove the standing cross tests (SFD-B207). During the time the marker is idle and the STX relay is normal, some miscellaneous tests are made to check that there are no false grounds or crosses within the connectors, by testing some of the leads to the connectors.

B1-5.7 CONTROL OF REGISTER GROUP SELECTION FROM MTC

Keys are provided on the older test frames to control register group selection. Newer frames provide an RG switch. The keys or switches function as shown in Table A.

TABLE A

KEY OPERATED	SWITCH POSITION	LEAD GROUNDED	ROUTE REL	TG*	OTHER DTM RELS	NOTES
All Normal	DP	D	D	0		Simulated 2LF- to LFD, LFMF or LFR- X CONN where all lines on a LL require same register group
MF	MF	MF	MF	1		
RT0	RT0	RT0	R0	2		
RT1	RT1	RT1	R1	3		
RT2	RT2	RT2	R2	4		
RT3	RT3	RT3	R3	5		
MLF	MLF	MLF	D/MF See note to the right.	0/1 See note to the right.		Used for 2 register groups where REG GRP is determined by VERT GRP. Used to verify VGR- to VGD or VGMF X-CONN.
MLF, RT0	VP0	MLF, RT0	D/MF/		VPT, VP0	Used for more than 2 REG GRPS where REG GRP is determined by VERT. GRP. Used to verify VGP- to LFD, LFMF, or LFR- X-CONN
MLF, RT1	VP1	MLF, RT1	R0-3	0-5	VPT, VP1	
MLF, RT2	VP2	MLF, RT2	See note to the right.	See note to the right.	VPT, VP2	

* To verify which register group DTM selected, REC key should be operated to force a trouble card, The TG- punch corresponds to register group selected and a D or MF punch should accompany TGO or TG1, respectively.

B1-6 IDENTIFICATION OF THE CALLING LINE

The equipment location identification of the calling line is needed to connect an originating register to the calling line. The identification of the calling line must be transmitted to the originating register where it is stored for further use on the call back connection by a completing marker. The calling line identification is also necessary to determine the type of register to be connected to the customer, and the class of service required. The steps followed in the identification of the calling line are shown as part of the sequence chart (SFD-B004).

To properly identify the calling line, information is required which will identify the line link frame on which the calling line appears and the location of the calling line on that line link frame.

Each line link frame consists of bays of ten crossbar switches mounted one above another.* Each customer line is associated with a hold magnet on a crossbar switch. Therefore, the identification of a particular hold magnet on a particular switch will identify the calling line. This identification is accomplished by dividing the line switches into the following groupings.

- (a) Horizontal Groups - The switches on each bay in the line link frame are numbered 0-9 from the bottom switch to the top switch. Switches of the same number on all bays of the line link frame comprise a horizontal group and are served by the same ten line links.
- (b) Vertical Groups - The hold magnets on each crossbar switch are divided into groups of five adjacent hold magnets, designated line groups. The ten line groups located in the same position in each horizontal group are designated as a vertical group. Therefore, a vertical group consists of 50 customer lines associated with the same five adjacent hold magnets in each horizontal group. A minimum of four and a maximum of 12 vertical groups,† numbered 0-11, can be equipped.
- (c) Vertical Files - The ten hold magnets in the same position in each vertical group are designated as a vertical file. There are five vertical files, numbered 0-4 in each vertical group.

* Some supplemented line link frame bays have split switches and are not arranged 10 switches one above the other. This type of frame has not been shown in the SFD.

† Initially a maximum of 14 vertical groups were provided. Older MTCs have 0-13VG keys as shown on SFD-B107.

Identification of the calling line can therefore be made in terms of line link frame number, horizontal group number, vertical group number, and vertical file number.

SFD-B107 is a simplified diagram showing line location, input to the DTM from the LL and LLMC as used on service calls and from the MTC for use on test calls.

B1-6.1 LINE LINK FRAME IDENTIFICATION

The line link frame identification of the calling line will be acquired by obtaining the line link frame tens digit number and the frame units digit number.

The line link marker connector will extend ground to the marker on two of the FU0-7 leads and optionally on one or two of the FT0-3 leads to identify in the marker the particular LLMC involved in this connection. Each line link marker connector is associated with one line link frame, therefore the identity of the LL is also known.

B1-6.1.1 Operation of the FT0-3 Relays (SFD-B107)

There are four frame tens (FT0-3) identification relays in the marker. The FT0-3 relays are associated with the FT0-3 frame tens digit identification test leads from the LLMC. The line link frame tens digit number will be identified upon operation of two, or optionally one, of the FT03 relays. Each LLMC will place ground potential on a particular test lead or leads when GTL1 is operated to correctly identify the tens digit number of the LL with which it is associated.

If the one ground option is provided, leads FT0-3 indicate directly tens digit 0 to 3. If the two ground (or 2/4 option) is provided, the Table B is used in interpreting the code.

TABLE B

Tens Digit	Leads Grounded
0	0, 3
1	0, 1
2	0, 2
3	1, 2
4	1, 3
5	2, 3

Note that adding the designations of the leads grounded gives the tens digit except for digit 0.

Auxiliary relays operated from the FT- relays are shown on SFD-B114.

B1-6.1.2 Operation of the FU0-7 Relays (SFD-B107)

There are five frame units (FU0,1,2,4,7) identification relays in the marker. Two leads out of five FU0-7 leads will be grounded by the LLMC. This will operate the two associated FU0-7 relays in the marker to identify the line link frame units digit in 2/5 code according to Table C when the GTL1 relay operates.

TABLE C

Units Digit	Leads Grounded
0	4, 7
1	0, 1
2	0, 2
3	1, 2
4	0, 4
5	1, 4
6	2, 4
7	0, 7
8	1, 7
9	2, 7

Note that adding the designations of the leads grounded gives the units digit except for digit 0.

Auxiliary relays operated from FU- relays are shown on SFD-B114.

B1-6.2 VERTICAL GROUP IDENTIFICATION

The marker in determining the identification of the calling line on the selected LL will first identify the vertical group, then identify the horizontal group, and finally, the vertical file of the calling line.

When a customer removes the receiver from the switchhook to originate a call, the customer line relay and a vertical group start relay are operated on the LL. On each LL there is one vertical group start relay associated with each vertical group of line terminations. Any customer within a vertical group desiring a dial tone connection will initiate the operation of the associated vertical group relay.

After the marker has been connected to the LL of the calling customer through the LLMC, the marker will test the VGTO-11 leads to the LLMC to determine which vertical group start relay has operated on the LL as an

indication of the vertical group in which the calling customer is located. If there are calling customers waiting for a dial tone connection in more than one vertical group on the line link frame to which the marker is connected, the marker will select one vertical group for service and exclude all other vertical groups. When the marker has determined the vertical group identification, the calling line identification is known to be within the 50 customer lines composing that vertical group.

B1-6.2.1 Operation of the VGG1 and VGG2 Relays (SFD-B108)

To initiate vertical group identification the vertical group gating relays VGG1,2 will be operated to connect the vertical group test relays to the LLMC, to identify the vertical group that is requesting service. The operation of the D, MF, or MLF relay will operate the VGG1,2 relays.

B1-6.2.2 Operation of the GK Relay (SFD-B108)

To check that the line identification gating relays, the vertical group gating relays VGG1,2, and the vertical file gating relay VFG have operated properly, the gating check GK relay will be operated.

B1-6.2.3 Operation of the VGT0-11 Relays (SFD-B108)

When a customer removes the receiver from the switchhook to originate a call, the customer line relay will operate a vertical group start VGS-relay on the LL. On each LL there is one vertical group start relay associated with each vertical group of 50 customer lines and the operation of any line relay within a vertical group will operate the associated vertical group start relay. The operation of a vertical group start relay will ground one VGT0-11 lead to the marker.

The marker provides facilities for testing either 8 or 12 vertical groups. However, 12 vertical groups are the maximum number that any LL can have. The number of vertical groups on the LL is optional up to the allowable maximum of 12.

Ground potential on one or more of the VGT0-11 leads will operate the associated group test relay VGT0-11 in the marker with the VGG1,2 relays operated. The operated VGT0-11 relay or relays will identify the vertical groups of the customer or customers requesting service.

B1-6.2.4 Operation of the VGR and VTK Relays (SFD-B108, B106)

The vertical group release relay VGR is operated as an indication that one or more VGT0-11 relays have operated (SFD-B108). The VGR relay serves to disconnect the marker if the call is abandoned by the customer during line identification.

The VGR relay in operating operates the vertical group test check relay VTK (SFD-B106). One of the purposes of the VTK relay is to allow sufficient time between the interval when the first VGT0-11 relay operates and when the last VGT0-11 relay operates. Since all VGT0-11 relays may not operate in the same time interval (slower operating relays), the operation of the VGR and VTK relays allows for this stagger time before the VGG1,2 relays are released and the paths to the vertical group test leads are opened. The VTK relay also gives an indication of false starts where the VGT-, VGR, VTK, and VTK1 relays operated and when the VGR relay released due to a customer replacing the receiver on the switchhook. The VTK and VTK1 relays operated with the VGR relay released indicates a false start or an abandoned call which will operate the DIS1,2 relays to release the marker (SFD-B502).

B1-6.2.5 Release of the VGG1,2 Relays (SFD-B108)

After an indication has been received that one or more vertical groups of calling customers have been identified, the vertical group gating VGG1,2 relays will be released. This excludes the future operation of a nonoperated VGT0-11 relay. The VGG1,2 relays are released when the VTK relay operates (SFD-B108).

B1-6.2.6 Release of the Nonpreferred VGT0-11 Relays (SFD-B108)

Operation of two or more VGT0-11 relays indicates that customers in more than one vertical group desire a dial tone connection. Since only one customer can be connected to an originating register at a time, it is necessary to prefer one of the customers requesting dial tone and to exclude all others. Therefore, the preferred VGT0-11 relay will be locked operated and all other operated VGT0-11 relays will be released. The VGT- relay remaining operated will allow calling customers within this vertical group to be selected for service.

The method of preferring one of the operated VGT0-11 relays and releasing the others is accomplished by using the junctor sequence circuit. It should be noted that regardless of the setting of the junctor sequence circuit vertical group two (VGT2) will always have first preference on a first trial call. However, on second trial calls the selection of the preferred VGT0-11 relay is only determined by the setting of the junctor sequence circuit. The selection preference of any VGT0-11 relay will vary with each connection set up by the marker as the junctor sequence circuit is advanced with each DTM usage. The operation of a particular junctor sequence JSQ0-5 relay will prefer one of the operated VGT0-11 relays and will lock up this selected relay. Upon the release of the vertical group gate relays VGG1,2, the preferred VGT0-11 relay will be locked operated through one of the junctor sequence contacts and all other VGT0-11 relays will be released. The detailed operation of the junctor sequence control is described in SCD-B4-1.1.

B1-6.2.7 Operation of the VTK1 Relay

The vertical group test check relay VTK1 is operated when all the non-preferred VGT0-11 relays have released, and with the preferred VGT-relay operated (SFD-B107). The operation of the VTK1 relay indicates that one and only one of the VGT0-11 relays is operated and the VGG1,2 relays have released. The VGR remains connected to the VGT- lead to monitor for abandoned calls.

B1-6.2.8 Operation of the VGA- and VGB- Relays on the LL (SFD-B107, B304)

The VGA- relay of the LL operates in parallel with VTK1 relay of the DTM when all nonpreferred VGT- relays have released with the preferred VGT-relay operated.

The operation of the VGA- relay on the LL initiates the selection of a horizontal group by extending the ten horizontal group test leads within the selected vertical group to the marker.

The vertical group VGB- relay on the LL operates after the vertical group has been selected and the vertical group test check VTK1 relay has been operated. However, the VGB- relay will only be operated after the line link connector has been seized and the connector cut-through relays operated (SFD-B304).

The operation of the VGB- relay on the LL assists the DTM in identifying the line group of the calling customer after the horizontal group has been selected. The operation of the VGB- relay also assists the DTM in determining the class of service of the calling customer after the vertical file has been identified.

B1-6.3 HORIZONTAL GROUP IDENTIFICATION

After the DTM has identified the vertical group, it operates the VGA-relay on the LL to extend to the DTM ten horizontal group identification test leads from the 50 line relays on the LL associated with the selected vertical group. The operation of any one of the five line relays within a horizontal group and within the selected vertical group places ground on the associated horizontal group identification test lead.

The DTM test for ground on the ten horizontal group identification test leads and determines in which horizontal group of the selected vertical group the calling customer line is located. If there are calling customers waiting for a dial tone connection in more than one horizontal group of the selected vertical group, the DTM selects one horizontal group for service and excludes all other horizontal groups. After the DTM has determined the vertical group and the horizontal group identification, the calling line identification is known to be within the five customer lines, composing the line group within the selected vertical group and horizontal group.

B1-6.3.1 Operation of the HGG Relay (SFD-B109)

The operation of the horizontal group gating relay HGG connects the horizontal group test relays to the horizontal group test leads from the LLMC to identify the horizontal group of the calling customer on the LL. When the D, MF, or MLF relays operate, the HGG relay operates.

B1-6.3.2 Operation of the HGTO-9 Relays (SFD-B109)

After the vertical group has been selected, it is necessary to determine which horizontal group within the selected vertical group should be served. The operation of one or more horizontal group test HGTO-9 relays indicates which horizontal group within the selected vertical groups have customers desiring dial tone connection.

The operation of any customer line relay in a horizontal group and within the selected vertical group with the associated VGA- relay operated grounds the associated horizontal group test lead HGTO-9 on the LL. Ground extended to the DTM over the horizontal group test leads HGTO-9 from the LL operates the associated HGTO-9 relays in the marker with the HGG relay operated. Thus, the horizontal group of customers within the selected vertical group is identified by the operation of the HGTO-9 relays.

B1-6.3.3 Operation of the HGR and HTK Relays

The horizontal group release relay HGR is operated as an indication that one or more HGTO-9 relays have operated. The HGR relay also monitors for a customer disconnect within the selected horizontal and selected vertical groups.

The HGR relay in operating operates the horizontal group test check relay HTK. One of the purposes of the HTK relay is to allow sufficient time between the interval when the first HGTO-9 relay operates and when the last HGTO-9 relay operates. Since all HGTO-9 relays may not operate in the same interval of time, the operation of the HGR and HTK relay allows for this stagger time before the HGG relay is released and the paths to the horizontal group test leads are opened. The HTK relay also gives an indication of false starts, where the HGT-, HGR, HTK, and HTK1 relays operated and when the HGR relay is released due to the customer replacing the receiver on the switchhook. The HTK and HTK1 relays operated with the HGR relay released indicates a false start or an abandoned call. The DIS1,2 relays will then be operated to release the marker (SFD-B502).

B1-6.3.4 Release of the Nonpreferred HGTO-9 Relays (FS7)

Operation of two or more HGTO-9 relays indicates that customers in more than one horizontal group desire a dial tone connection. Since only one

customer can be connected to an originating register at a time, it is necessary to prefer one of the customers requesting dial tone and to exclude all others. Therefore, the preferred HGTO-9 relay is locked operated and all other operated HGTO-9 relays are released. The HGT-relay remaining operated allows the calling customers within this horizontal group and the selected vertical group to be selected for service.

The method used to prefer one of the operated HGTO-9 relays and to release all other HGTO-9 relays is similar to the method used in preferring one of the VGT0-11 relays for service as described in SCD-B1-6.2.6 except no horizontal group has a continuous first choice preference as VGT2.

B1-6.3.5 Operation of the HTK1 Relay (SFD-B107)

The horizontal group test check HTK1 relay is operated when all the nonpreferred HGTO-9 relays have released with the preferred HGT-relay operated. The operation of the HTK1 relay indicates that one and only one of the HGTO-9 relays is operated and the HGG relay has released.

B1-6.4 VERTICAL FILE IDENTIFICATION

Vertical group and horizontal group identification is made from information received by the DTM via the LLMC. Vertical file identification cannot proceed until the DTM has seized a trunk link frame with an idle OR and has connected to the LL via the line link connector (LLC). Selection and seizure of a TL is described in SCD-B3. The seizure and connection to a LL via the LLC is described in SCD-B4. To complete the description of line identification, it is assumed that these functions have been completed during vertical group and horizontal group identification. If the connection to the LL via the LLC has not been completed, vertical file identification is delayed.

After the DTM has identified the vertical group and horizontal group and has connected to the LL via the LLC, it operates relays in the LL to extend the five vertical file identification test leads VFT0-4 from the five line relays of the selected line group (SFD-B107). Each vertical file identification lead connects to a contact on one line relay in the selected line group. The operation of one or more line relays in the line group will have placed ground on the associated VFT-leads.

The DTM tests for ground on the VFT0-4 leads and determines in which vertical files of the selected line group the calling customer line is located. If there are calling customers waiting for a dial tone connection in more than one vertical file of the selected line group, the DTM selects one vertical file for service and excludes all other vertical files. After the DTM has determined the vertical group, the horizontal group, and vertical file identification, the calling line identification is complete.

B1-6.4.1 Operation of the VFG Relay (FS8) (SFD-B109)

The vertical file gating relay VFG, when operated connects the vertical file test leads VFT0-4 from the LL to the vertical file test VFT0-4 relays to identify which vertical file or files are requesting service. The operation of the D, MF, or MLF relay operates the VFG relay.

B1-6.4.2 Operation of the Horizontal Group Relays HGA-, HGB- on the LL (SFD-B107)

The HTK1 relay of the DTM and the horizontal group relays HGA-, HGB- on the LL operate when all nonpreferred HGT0-9 relays have released with the preferred HGT- relay and connector cut-through relays operated. The operation of the HGA-, HGB- relays on the LL with the VGB- relay on the LL operated narrows the selection to five lines.

B1-6.4.3 Operation of the HGK Relay (SFD-B107)

As a check that HGA-, HGB- relays on the LL have operated, the HGK relay operates.

B1-6.4.4 Operation of the Line Group LG- Relay on the LL (SFD-B107)

On the LL there is one LG- (line group) relay associated with the five customer lines that have been selected by the operation of the vertical group and horizontal group relays. The group of five customer lines is called a line group. There are ten LG- relays per vertical group. Therefore, if the line link frame has 12 vertical groups there will be 120 LG- relays on that LL (one line group relay for each five customer lines). By identifying the vertical group of the calling customer the identity of the customer line group is known to be within the ten line groups associated with the selected vertical group. By identifying the horizontal group within the selected vertical group of the calling customer line the complete identity of the calling customer line group is known.

The operation of the line group relay extends five vertical file test leads VFT0-4 to the LL to determine the vertical file numbers of the customers desiring service.

After the horizontal group check (HGK) relay has operated, battery potential is extended to the LL on the BS lead to operate the LG-relay.

B1-6.4.5 Operation of the VFT0-4 Relays (SFD-B107), B109)

When a customer removes the receiver from the switchhook to originate a call, the customer line relay operates. The operation of any customer line relay in a vertical file and within the selected vertical group and selected horizontal group grounds the associated vertical file identification test lead VFT0-4 from the LL.

B1-6.4.6 Operation of the FR Relay (SFD-B109)

The vertical file release (FR) relay is operated as an indication that one or more VFTO-4 relays have operated. The FR relay also monitors for a customer disconnect within the selected vertical file, horizontal group, and vertical group in a manner similar to the description for the HGR relay (SCD-B1-6.3.3).

B1-6.4.7 Release of the VFG Relay (SFD-B109)

After the FR relay operates as an indication that one or more vertical files of calling customers have been identified, the vertical file gating relay (VFG) releases to exclude the future operation of a non-operated VFTO-4 relay on this call.

B1-6.4.8 Release of the Nonpreferred VFTO-4 Relays (SFD-B109)

If two or more VFTO-4 relays have operated indicating that customers in more than one vertical file desire a dial tone connection, the one VFTO-4 relay among the operated VFTO-4 relays with the higher selection preference will be locked operated and all other VFTO-4 relays will be released. The VFT- relay remaining operated selects the calling customer within this vertical file for service.

The method used to prefer one of the operated VFTO-4 relays and to release all other operated VFTO-4 relays is accomplished in a manner similar to the method used in preferring one of the HGT0-9 relays as described in SCD-B1-6.3.5.

B1-6.4.9 Operation of the FTK1 Relay (SFD-B107)

The vertical file test check relay FTK1 is operated when all nonpreferred VFTO-4 relays have released with the preferred VFT- relay operated. The operation of the FTK1 relay indicates that one and only one of the VFTO-4 relays is operated and the VFG relay has released.

B1-6.4.10 Junctor Sequence Walking Circuit

The DTM provides a walking circuit for equalizing preference for various marker selections and to safeguard service by shifting the entrance point of preference circuits. Circuit functions using the walking circuit for line identification are:

- (a) Vertical Group Selection (SCD-B1-6.2.6)
- (b) Horizontal Group Selection (SCD-B1-6.3.5)
- (c) Vertical File Selection (SCD-B1-6.4.8)

Operation of the junctor walking circuit is described in SCD-B4-1.1.

B1-7 MARKER SUPERVISION DURING LINE IDENTIFICATION AND SELECTION

While line identification is in progress, the marker maintains constant supervision over its selections, namely, vertical group, horizontal group, and vertical file. Withdrawal of demands for dial tone during these selections will result in marker release.

In any stage of line identification the release of relays VGG1, VGG2, HGG, or VFG releases all but one VGT-, HGT-, or VFT- relay. The test check relays VTK and VTK1, HTK and HTK1, and FTK1 are thereby operated. Relay VGR or FR is held by the ground on the line link frame that originally operated the selected test relay. If at any stage of line identification this ground is removed (abandoned call), the VGR, HGR, or FR relay releases. This condition together with the operated test check relays operates relays DIS1/2 (marker disconnect) (refer to SFD-10-01-B502) causing the marker to disconnect without a trouble record (normal release).

B1-8 MASTER TEST CONTROL - DT AND OR CLASS OF TEST - SIMULATION OF PORTIONS OF LINE LINK FRAME, LINE LINK MARKER CONNECTOR, AND PREFERENCE CONTROL

The DT class of test is used for testing dial tone markers and the various other circuits which the markers control.

The OR class of test establishes a connection through the network from a test line to an originating register which is then tested by the automatic monitor register and sender test circuit. (AMRST).

The information required to prime the marker is similar for both classes of test calls. The master test control (MTC) simulates portions of a line link frame, line link marker connector, and preference control. It gains access to the marker via the master test frame connector (MTFC). Inputs to the DTM from the MTC are held open in the MTC by contacts on isolating relays (generally designated as MC-, TS- or K-). These isolating relays operate after the MTC has made a check that required test relays (generally designated MT-) have operated in the DTM.

B1-8.1 INITIAL PRIMING INFORMATION FROM MTC

The CKG2 lead (SFD-B104) and TM lead (SFD-B110) are closed automatically with no control by keys on the MTC. They simulate the CKG lead from the LLMC and the release of the MSK, MAK, and MCK relays of the DTM which occurs on service calls by opening chain paths through MS- relays of the preference control circuit when one or more MS- relays operate.

With the TR2 key (SFD-B106) normal, the TRK lead is grounded to simulate a TRK (first trial) signal from the LL via the LLMC.

With the TR2 key (SFD-B106) operated, the TR2 lead is grounded to simulate a TR2 (second trial) signal from the LL via the LLMC.

With the TRS key (SFD-B106) operated, the TRS lead is grounded to simulate a TRS (transfer start) signal from the LL via the LLMC.

Under control of the RG switch or one of the keys MLF, MF, or RT0-3 (SFD-B105), one of the leads D/MF/MLF/RT0-3 is grounded to simulate closure of ground to an LF- cross-connection by operation of an MS-relay in the PC (SFD-B104), Table D shows various conditions.

TABLE D

Note	RG Switch Provided (STD)	Keys Provided (MD)	Simulates LL Having Lines Request Originating Register in Register Group	TBL Card Designation
	Pos	Keys Opr.		
1	D	None	D	D, TG0
	MF	MF	MF	MF, TG1
	MLF	MLF	D/MF	MLF, (D, TG0) / (MF, TG1)
	RT0	RT0	R0	MLF TG2
	RT1	RT1	R1	TG3
	RT2	RT2	R2	TG4
	RT3	RT3	R3	TG5
2	VP0	MLF, RT0	NOTE 2	MLF, NOTE 2
2	VP1	MLF, RT1	NOTE 2	MLF, NOTE 2
2	VP2	MLF, RT2	NOTE 2	MLF, NOTE 2

- NOTES:
1. Use only when there are two register groups, D and MF. Marker VGR- cross-connections determine whether the D or MF register group is required depending on which vertical group is used.
 2. Use when there are more than two register groups. Marker VGP- X CONN determines whether D, MF, R0, R1, R2, or R3 register group is required depending on which vertical group is used. Trouble card should always show MLF along with indication of register group D, TG0/MF, TG1/TG2/TG3/TG4/TG5.

B1-8.2 LINE LOCATION INFORMATION

On OR class of test with the NTC (no test connector) key operated or on DT class of test with the NTC key in either position, line location should be set up on keys or switches FT-, FU-, VG-, HG-, and VF- (SFD-B107). On OR class of test, with the NTC key normal, the OTL2 relay will operate to provide line information which has been cross-connected for an originating test line. In this case the line location keys need not be operated. They are ineffective, however if they are inadvertently operated.

Line Link Frame Number on the FT- and FU- leads is closed early to simulate FT- and FU- leads from the LLMC.

Vertical group number on the TVGT- leads is also closed early by either the KVGL, 2 or the CTL2 relays to simulate VGT- leads from the LL via the LLMC. When vertical group selections have been made by the DTM, a VGA- relay is normally operated in the LL via the LLMC. Instead, however, either the KHGT or the VGA relay of the MTC is operated depending on whether line location is being generated by the line location keys or the OTL2 relay, respectively.

Operation of the KHGT or VGA relay in the MTC grounds one of the THGT- leads to the DTM to simulate ground on an HGT- lead from the LL via the LLMC.

By this time, the marker should have connected to the LL via the LLC. When horizontal group selection has been made by the DTM, HGA- and HGB- relays are operated in the LL and close a ground on the HGK lead to operate the HGK relay in the DTM. The HGK relay closes ground on an HGK lead to operate either the KV or the HGK relay of the MTC, again depending on whether the line location information is being generated by keys or switches or by the OTL2 relay. Operation of the HGK relay in the marker applies battery to the BS lead to operate an LG- relay in the LL. Operation of the KV or HGK relay in the MTC grounds a TVFT- lead to the DTM to simulate ground on a VFT- lead from the LL.

B1-8.3 CONTROL LEADS

On a service call, start battery via the MSA lead or MSB lead from the LL operates an MS- relay in the preference control circuit (PC) to bid for a DTM. The same start battery and the ground through the winding of the MS- relay is extended through the LLMC on the MS1 or MS2 lead to operate the OC1 relay in the DTM after the VTK relay has operated. The OC1 relay operates the OC relay which operates the TC and TC1 relays of the LL to open the start battery. The MS- relay of the PC now remains operated to battery through the OC1 relay winding.

To simulate this on a DT or OR class of test, the MTC provides resistance battery to operate the MS relay which simulates an MS- relay of the PC. When the VTK relay of the DTM operates, the OC1 relay of the DTM operates to ground through the winding of the MS relay of the MTC. The OC1 relay of the DTM operates the OC relay which grounds the TC1 lead to the MTC to operate the TC1 relay which simulates the TC and TC1 relays of the LL. The TC1 relay opens the battery which originally operated the MS relay of the MTC and leaves it held in series with the OC1 relay of the DTM. Later, when the marker is ready to release, it operates the DIS1 and DIS2 relays to release the OC1 of the DTM and the MS of the MTC.

The MTC provides a closure between the DTK and G leads (SFD-B106) which simulates a similar closure on service calls via the LLMC, the DT relay of the LL and the LLC.

When the DTM encounters certain trouble or busy conditions on service calls, it grounds either the BT or the TRL lead (SFD-B106) to operate the TRL relay of the LL as a trouble release signal. On DT or OR test calls, if the DTM encounters the same conditions, it again grounds either the BT or TRL leads to operate either the BT or TRL relay and light the BT-OF or TRL lamp in the MTC.

On service calls, operation of the TRL relay in the LL operates the TR relay (SFD-B106). With both relays TRL and TR operated, the path holding the MS- relay of the PC (SFD-B104) is opened to release the connection between the LL and the DTM. On a DT or OR class of test, operation of either the BT or TRL relay of the MTC causes release of the connection from the MTC to the DTM via the MTFC.

B1-9 LINE LOAD CONTROL

Line load control provides the means for temporarily reducing the originating attempts from line link frames. When line load control is provided, the lines on each line link frame are divided into classes A, B, and C. Line load control relays are provided for lines in class B and class C only. These relays are manually controlled from a central point in the office. Vital lines such as police, fire, hospitals, etc. are assigned to class A which is exempted from line load control.

B1-9.1 LOAD INDICATORS

Several indicators are provided on the line load control panel which aid in determining when and how to apply line load control.

B1-9.1.1 Line Link Frame G- Lamps

As noted in SCD-B1-4.3, each line link frame is arranged to light an associated red G lamp at the line load control panel when calls are waiting for an interval greater than 5.4 to 8.0 seconds (SFD-B106, B112).

B1-9.1.2 Originating Register Group Busy ORST- Lamps

Whenever a DTM finds all originating registers in a group busy, the TBTA relay operates to ground a lead which lights a red ORST- lamp corresponding to that register group (SFD-B112). The ground from the DTM is momentary, but it causes the RB2 relay of the group busy circuit to lock up for 9.6 to 13.3 seconds until the RT timer (SFD-B511) times out to release the RB2 relay (SCD-B5-2.20).

B1-9.1.3 Marker Group Busy MBA- Lamps

A series circuit through contacts of the AMB relay of each DTM operates the B1 relay of the all markers busy circuit whenever all markers are busy at the same time (SFD-B112). The B1 relay starts the 40-62 second TM timer. If any marker becomes idle prior to time out, release of the B1 relay recycles the timer. If the timer times out, it operates the T relay which operates the B relay. The B relay lights a red MBA- lamp associated with the group of dial tone markers. The B relay also releases the T relay, locks to the B1, and recycles the timer. If any DTM becomes idle after time out, the release of the B1 relay releases the B and extinguishes the MBA- lamp.

B1-9.1.4 Load Meter

A load meter is provided at the line load control panel which indicates the -48 volt current drain of the whole No. 5 Crossbar office. The meter is actually a millivolt meter calibrated 0-100 and is connected across a shunt in series with the -48V bus which feeds the office. The load meter is not intended to provide an accurate measurement of current, but rather a relative measurement. The interpretation of the meter reading depends on the size of the office. A normal peak load reading for a small office might be 20, while that for a larger office might be 70. Readings much in excess of normal peak readings for the office in conjunction with other load indicators may be indicative of overload conditions. If applications of line load control are effective in reducing the offered load, the reading of the load meter should decrease.

Where more than one office uses the same -48 volt supply, the load meter indicates the combined load for both offices and loses its effectiveness as a load indication for either office.

B1-9.2 APPLICATION OF LOAD CONTROL

Where load control is to be applied to class B lines, the CLB key is operated (SFD-B112). This causes the HB, AB, and B relays to operate. The B relays enable B keys, one for each line link frame. Operating a B key associated with any LL operates the B relay in that line link frame. The B relay lights a B lamp associated with that LL at the line load control panel and also provides a locking ground for the AB and HB relays, so that the B lamp will remain lighted, even though the CLB key is released, as a reminder that the individual B keys should also be released. When the B relay on a LL operates, it opens the operate path for all even VGS- relays (SFD-B102) which do not have a strap from G- to VG- to bypass the break contact of the B relay. Insertion of this strap rates the lines of that vertical group as class A which is not subject to line load control.

To apply line load control to class C lines, CLC and C keys are used in the same manner described for class B lines. This affects lines in odd vertical groups except where a G- or VG- strap converts the vertical group to class A.

B1-9.3 ALARM

When either the AB or AC relay operates, battery is applied to the MJ lead to the alarm circuit (SFD-B112) to sound a major alarm and light the aisle pilot lamp. The alarm may be retired by momentarily operating the nonlocking AR key, operating the RC relay which locks.

B1-9.4 CANCEL GROUND TEST

Whenever line load control is applied, leads are grounded to the JLK circuit to cancel trouble records by completing markers on ground tests to help reduce marker holding time.

SECTION B, PART 2

CONNECTION TO TRUNK LINK FRAME AND

ORIGINATING REGISTER

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B2 CONNECTION TO TRUNK LINK FRAME AND ORIGINATING REGISTER

When a DTM has been seized and has received input information through the LLMC, it proceeds to select a trunk link frame (TL) having idle originating registers (OR) of the correct type. It then proceeds to select and connect to an OR.

B2-1 TRUNK LINK FRAME SELECTION

B2-1.1 TEST FOR IDLE ORIGINATING REGISTERS ON TRUNK LINK FRAMES

The operation of one of the relays D, MF, or R0-4 (SFD-B105) causes operation of relays FCD0, 10, 20, FCM0, 10, 20, or FC0-3, 10-13, 20-23 frame connect relays respectively. The operation of the FC- relays causes operation of the FCK relay. When the frame connect relays FCD-, FCM-, or FCR- operate, they extend frame test leads FTC-, one to each trunk link frame (SFD-B202). The FTC- leads terminate in FTC- terminals at the TL which are cross-connected to the FT- terminals of each register on that frame of the associated group. For instance, if FCD- relays are operated they would close through FTC- leads to each TL which are cross-connected to FT- terminals of each dial pulse OR associated with the group intended to be selected when the D relay has been operated via the LLMC.

The FT- terminal associated with each OR is connected to ground in the OR through normal contacts of relays of the OR, so that if the OR is either busy in service or is made busy (MB relay operated), the ground will be open.

B2-1.2 TRUNK LINK FRAME BUSY TEST

To prevent marker delays it is necessary to determine which TLs are occupied by other markers before the TL with an idle OR can be selected. The operation of the BC0, 10, and 20 relays (SFD-B204) extends the windings of the FBO-29 relays (SFD-B202) to their associated TL to check if that frame is busy. If the TL is busy, the associated FB- relay operates. To select a TL, the associated FTC- relay must be operated while the FB- relay is nonoperated.

B2-1.3 TL PREFERENCE ORDER OF SELECTION CONTROLLED BY MEMORY OF PREVIOUSLY SELECTED TL

Frame memory relays (SFD-B205) have been provided to equalize traffic to the TLs. The frame memory group FMG- relay and the frame memory FM0-4 relay will be held operated from the previous call to record the identification of the TL used in that connection. This information is locked in, and on the next call will be used to make the succeeding TL first choice for the marker. However, if the first choice TL is not available for service, the next preferred TL is selected (SFD-B203).

As described in SCD-B2-1.6, after the TL has been selected, the frame memory relays used to identify the last TL used are released. The frame memory relays identifying the TL used in this connection are then operated.

B2-1.4 FRAME SELECTION, OPERATION OF THE FS0-29 RELAYS (SFD-B203)

The operation of a frame select FS0-29 relay (SFD-B203) indicates the TL to be selected to complete this connection. The operation of the FS-relay depends on:

- (a) The operation of the FCK relay indicating that either the FCD-, FCM-, or FCR- relays have operated (SFD-B105).
- (b) The operation of the FTC- relay with the associated FB- relay released, indicating an idle TL with an idle originating register of the desired type (SFD-B202).
- (c) The setting of the FMG- and FM- relays (SFD-B203).
- (d) The operation of the FMG relay indicating that the frame memory relays have been held operated from the previous call (SFD-B205).

The FS- relay which operates will generally be associated with the second higher-numbered frame than the frame recorded on the frame memory relays. The reason for advancing the frame selection in steps of twos is in cases of paired TLs where all channels are busy and the marker is recycled, it will always be advanced to a different TL. This prevents the marker from staying in the same TL and allows another set of junctions to be tested.

B2-1.5 TRUNK LINK FRAME SEIZURE (SFD-B204, SD-26039-FS2, 3, 4)

Operation of an FS- relay closes start battery to the preference control circuit associated with the trunk link frame having the same number as the operated FS- relay.

B2-1.5.1 Preference Control Circuit

The preference control circuit associated with trunk link connectors provides two preference relays, MP- (marker preference) and E- (emergency marker preference), per marker for each trunk link connector. There is means for detecting trouble associated with both the MP- and the E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by three chain circuits which enable connection of one marker at a time to a trunk link frame. Similar independent chains interconnect the E-relays. While the following description is for MP- relays, it applies equally to E- relays.

B2-1.5.1.1 MP- Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a TL) MP- relay operation is straightforward. A start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operate chain to ground at the winding of the first relay in the operate chain (shown on SFD-B204 as associated with the last CM or DTM). In periods of heavy traffic two or more markers may initiate request either simultaneously or in rapid succession.

Assume that the first CM and the last CM or DTM (SFD-B204) initiate simultaneous requests (Apply start battery) for connection to the same TL. Both MP- relays will operate and lock. If, however, the last CM or DTM has initiated a request slightly before the first CM, the MP- relay for the first CM could not have operated because ground for its winding would have been opened by the operate chain at the MP- relay for the last CM or DTM.

On the other hand, if the first CM initiated a bid first, any other marker ahead of it in the operate chain could subsequently operate its MP- relay.

B2-1.5.1.2 MP- Relay Work Chains

Since it is possible to operate two or more MP- relays at the same time, two work chains determine which MP- relay does the work. The work chains progress through contacts of the MP- relays in the opposite direction to the operate chain, starting with ground at contacts of the MP- relay for the first CM. If the MP- relay for the first CM is operated, one work chain ground will operate the M trunk link connector relay whether or not other MP- relays are operated. The M- relay operates other connector relays by closing through battery supplied by the marker.

The second work chain grounds the CK lead to the marker which has gained access to the trunk link frame to operate the TFK1 relay in the marker. The operated TFK1 relay provides locking ground for the FS- relay (SFD-B203) which had closed through the start battery to the PC. The TFK1 relay also opens the ground from which the FS- relay had operated.

When the marker which has seized the TL has finished its job and opened the start lead to the PC, its MP- relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated now functions as just described. This continues until all operated MP- relays have been served.

B2-1.5.1.3 Emergency Transfer

Two sets of preference relays MP- and E- are provided in the PC (SFD-B204) either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR relay are normal so that MP- relays are active. When all MP- relays are normal, ground through all the break contacts of the operate chain is connected to one side of the CH relay winding and ground through all the break contacts of the work chain which operates connector relays is connected to the other. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP- relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP- relays are all normal, one side of the CH- relay winding will have ground and the other resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP- relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other and will operate.

If the CH relay operates, even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the ST, CK-, and MC- leads from MP- relays to E- relays. The TR relay also brings in a minor alarm and lights a CH lamp.*

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP chain if the TR key is normal or to the E- chain if the TR key is operated.

B2-1.5.1.4 Manual Transfer

By operating the TR key [located at the TLCC (Trunk Link Connector Control) frame] preference control can be manually transferred for the MP- to the E- relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E- relays. If the CH relay operates, it operates the TR relay which locks and releases the TR- relays to transfer preference back to the MP- relays.

* Although the CH lamp is shown as part of the trunk link connector circuit, it and the alarm release key are located on a frame designated as "trunk link connector control."

B2-1.5.2 Frame Busy Signal

When the trunk link connector relays operate, they ground FB- leads to all markers (DTM and CM) (SFD-B202, 304) as an indication that the trunk link frame is now busy. In all markers except the one that seized the TL, operated FB- relays (SFD-B203) cause the release of associated FS-relays (if operated) and operation of another FS- relay (assuming another FTC- relay is operated with a normal FB- relay). In the marker which had seized the TL, the locking ground from the operated TFK1 prevents release of the FS- relay. The operated TFK1 also prevents operation of any other FS- relay by its removal of the operate ground for FS- relays. Thus, any other markers handling dial tone or outgoing connections will remove their bid for the particular TL and possibly bid for another which had idle originating registers or idle trunks. As will be seen later, completing markers handling incoming trunk calls can only go to one TL and will continue their bid for the same TL.

B2-1.6 RECYCLE OF FRAME MEMORY PREFERENCE (SFD-B205,B004)

After the trunk link frame has been seized, the marker resets the frame memory relays (SFD-B205). The operation of relay TFK1 removes the locking ground from relays FM- and FMG- held from the previous usage, thereby allowing them to release. The release of relays FM- and FMG- releases relay FMK which releases relay FMG. The release of relay FMG, together with the operated relay FS- on this usage, operates the FM- and FMG- relays that correspond to the trunk link frame being used. Relay FMK reoperates. Because relay TRK1 is operated, relay FML (frame memory lock) operates and relay FMG remains nonoperated and provides a locking ground for the FM- and FMG- relays. The operation of relay FML releases relay BC0, 10, and 20 (SFD-B204), opening the trunk link frame test leads (SFD-B202) and releasing the operated FB- relays. The frame memory lock relay (FML) operated opens a break contact in the FMK relay circuit. This now ensures that the FMK relay will remain operated only when both FM- and FMG- relays are operated. The FMK and FML relay operation is represented on the trouble record card by progress punch FML. Failure to lock the new frame memory relays will be detected at the time the dial tone marker prepares to operate the disconnect relays DIS1 and 2 through make-contacts of the FML and FMK relays (SFD-B502). A trouble record will be produced showing no FML punch.

B2-1.7 CONTROL OF TRUNK LINK FRAME SELECTION BY THE MASTER TEST CONTROL CIRCUIT (SFD-B202)

Three methods of controlling trunk link frame selection from the master test control circuit are provided on DT (dial tone marker) and OR (originating register) test calls. They are:

- (a) Normal (FS and NTFS keys normal)

- (b) Selection of a particular trunk link frame having idle registers (FS key operated)
- (c) Selection of a particular trunk link frame whether or not there are idle registers (NTFS key operated).

B2-1.7.1 FS and NTFS Keys Normal

With the FS and NTFS keys normal, the MT4, 14, and 24 and MT9, 19, and 29 relays in the dial tone marker are not operated (SFD-B204). The marker tests for trunk link frames having idle registers in the normal manner, and therefore selects the most preferred trunk link frame just as on a service call.

B2-1.7.2 FS Key Operated

With the FS key operated, the MT4, 14, and 24 relays in the dial tone marker are operated. A check is made that these relays have operated before the test is allowed to proceed (see SFD-B405 and SCD-B4-1.1.1.2). Operation of these MT- relays removes battery from the windings of all FTC- relays and extends the windings to the master test control circuit. Battery from the FTC ballast lamp in the master test control is steered to any desired FTC- relay by having preset the proper FGO, 1, 2 key and the FS- key or switch. In this mode, the dial tone marker functions as on a service call in that the particular FTC- relay can only operate if there is an idle originating register on the trunk link frame.

B2-1.7.3 NTFS Key Operated

The NTFS key is intended for use when it is desired to select an originating register which is maintenance busy and there is no idle originating register which is not maintenance busy on the trunk link frame. It should be noted that with the NTFS key operated, no test is made of the FTC- leads to the trunk link frame. With the NTFS key operated, the KMTS9 relay of the master test control operates. This, in turn, causes the MT9, 19, and 29 relays of the dial tone marker to operate over the MT9 lead. A check is made that the MT9 relay has operated before the test is allowed to proceed (see SFD-B402 and SCD-B4-1.1.1.2). These test relays operated open all the FTC- leads toward the trunk link frames and extend them back to the master test control circuit. Wire spring dial tone markers operate a WSD* relay in master test control circuit.

* Trunk link frame selection with the NTFS key operated for U-type dial tone markers and for all completing markers function quite differently than for wire spring dial tone markers. For this reason, the WSD relay is operated in the master test control when it connects to a wire spring dial tone marker.

The WSD relay opens the MAK1 and provides a ground which is steered under control of preoperated FS- keys or switches and FG0/1/2 keys to directly operate the desired FTC- relay in the dial tone marker.

B2-2 TEST AND SELECTION OF AN IDLE REGISTER (SFD-B208, 209)

As soon as the trunk link frame and connector is seized, the marker proceeds to test and select an idle originating register. The various steps are as follows.

B2-2.1 TRUNK BLOCK AND TRUNK GROUP CONTROL

The marker must indicate to the TL which trunk block and trunk group are used for the originating register route. The TLs provide for a number of trunk blocks† [depending on the type of TL0 and 20 trunk groups (TGs)].

Only trunk block 0 (TB0) and trunk groups 0-5 (TG0-5) are used for originating registers. One TG- is used per register group (or route).

Originating registers are restricted to the "A" appearances on the TLs.

B2-2.2 CROSS-CONNECTION OF TG- TO FA- TERMINALS

Each register has an F lead (SFD-B209). This lead is connected to an FA- terminal. All those FA- terminals corresponding to registers of the same type have the same TG number and are connected to the corresponding TG- terminal.

B2-2.3 BT LEADS

In the register, each F lead is connected through an F relay winding (through contacts which are open while the circuit is busy) and then to a BT terminal. Registers of the same TB number are connected to the terminals on the same TB relay. Thus, a continuous path through the OR or trunk from the F lead to the BT lead indicates an idle OR or T.

† Most trunk link frames have large trunk switches which provide a total of 160 trunk terminations of which no more than 120 can be used for outgoing trunks and originating registers. Each group of trunks or ORs is assigned one of six TB- numbers (trunk block) and are of 20 TG (trunk group numbers) for a maximum total of 120 routes.

Trunk link frames having minitrunk switches provide a maximum of 200 trunk terminations. Each group of trunks or ORs is assigned one of 10 TB- numbers and are of 20 TG- numbers for a maximum total of 200 routes.

B2-2.4 OPERATION OF THE MARKER TBK AND TSE1,2 RELAYS AND THE TRUNK BLOCK RELAY ON THE TL

Battery potential is extended to the TL over the TB0 lead to operate the TB0 trunk block relay when the trunk link connector relays operate (SFD-B209). Ground potential transmitted to the marker over the TBK lead from the TL operates the marker TBK relay indicating that the trunk block relay in the TL has operated.

When the TLC relay operates it supplies ground through the TS0-4 break-contacts to operate the TSE1, 2 relays (SFD-B208).

The trunk select end TSE1-2 relays when operated provide off-normal battery for the testing and selection of an idle originating register (SFD-B209).

B2-2.5 OPERATION OF THE TTO-4 RELAYS (FS4)

With the operation of the M- relays of the TLC and the trunk block relay on the TL, ground is extended from the marker TG- lead through the TL and back into the marker over the BT0-9 leads to operate one or more trunk test TTO-4 relays. Since the TTO-4 relays are double-wound, the operation of each one signifies that either one or two originating registers is idle. To identify which one of the two BT- leads is grounded, an odd and even preference lockout scheme is used, as described in SCD-B-2.2.7.

The frame cut-through F relay in the originating register circuit will not be operated in series with the windings of the TTO-4 relays as the resistance of TTO-4 relays is too high.

B2-2.6 OPERATION OF THE TS0-4 RELAYS AND RELEASE OF THE TSE1,2 RELAYS AND TTO-4 RELAYS

When the TSE1, TBK, and MAK1 relays operate, ground is extended through an operated JSQ0-5 relay to the TTO-4 relay preference chain to operate the preferred trunk select TS0-4 relay (SFD-B208). The TS0-4 relay which operates locks to the TLC relay operated, releases the TSE1,2 relays which in turn release all operated TTO-4 relays (SFD-B209).

The JSQ0-5 relay walking circuit rotates the preference to registers and safeguards service by changing entrance points to the chain circuit. The operation of the junctor sequence walking circuit is described in SCD-B4-1.1.

B2-2.7 OPERATION OF THE OTS AND OT RELAYS OR THE ETS RELAY

The release of the TSE1 and the operation of the TS- relay will select two of a possible ten BT- leads. These leads, which indicate idle register circuits when grounded, are extended to an odd (OTS) relay and an even (ETS) relay from which only one of the two BT leads is selected. If at this time only one of the two leads is grounded, the operated or unoperated condition of the sequence relay SQ1 has no significance. Therefore, if the odd BT lead is grounded, the OTS relay operates, and, if the even BT- lead is grounded, the ETS relay operates. If, however, the BT- leads are both grounded, then the operated or unoperated condition of the sequence relay SQ1 determines the selection of either the OTS relay or the ETS relay.

The ETS and OTS are double-wound relays in which the current through the primary winding (10 or 12 ohms) is forward-biasing (tends to operate) and the current through the secondary winding is reverse-biasing (tends to release). When both windings of one of the relays are energized, the current through the reverse-bias winding is of sufficient magnitude to hold the relay unoperated. If the SQ1 relay is nonoperated, the reverse-bias winding of the ETS is opened. Therefore, with ground on both the odd and even BT- leads, the ETS relay would operate and the OTS relay would be biased to nonoperate.

However, if the SQ1 relay were operated, the OTS reverse-bias winding is opened and the OTS relay would be preferred. Operation of either an OTS or ETS relay opens the operating circuit of the other relay.

B2-2.8 SEIZURE OF THE SELECTED REGISTER AND OPERATION OF THE F RELAY IN THE REGISTER

As shown in SFD-B209, the marker makes the OR busy test with the high-resistance T10-4 relays. The resistance of the T10-4 relays is large enough to prevent the operation of the originating register F relay when their windings are in series. Therefore, the T10-4 relay would operate, while the F relay would remain unoperated.

The operation of the ETS or OTS relay provides a low-resistance circuit from battery potential to the winding of the F relay. Therefore, the operation of the ETS or OTS relay operates the F relay. The OTS or ETS relay locks operated in series with the F relay.

B2-2.9 ALL ORIGINATING REGISTERS BUSY

When the FCD-, FCM-, or FCR- relays are operated, the FTCK-29 relays are connected to their respective TL, and operate if there are any idle registers on the TL. The operation of any FTC- relay operates the FTCK and FTCK1 relays as an indication that there are idle originating registers.

B2-2.9.1 All Registers Busy Timing - (Mfr Disc. Option)

If all the originating registers are busy, the TBT relay (SFD-B204) will be operated. The operation of the TBT relay starts the TBT tube timer (SFD-B111). The TBT tube timer provides a delay of from 1.0 to 1.5 seconds before operating the associated TBTA relay. When the TBTA relay operates, the FM relay (SFD-B415) and route advance RAV1 relays (SFD-B206) operate to release the marker.

However, if any of the registers become idle before the TBT tube timer operates, the TBT relay is released and the timer is restored to normal.

B2-2.9.2 All Registers Busy Timing (Standard Option)

With the standard option, the addition of the MAK1 relay back contacts causes the TBTA relay to operate directly from the TBT on service calls so that timing consists only of the operate times of the TBT and TBTA relays. Both the TBT and the TBTA relays are relatively slow operate by comparison with operate times of FTC-, FTCK, and FTCK1 relays, so that if there is an OR available, the TBT will be released before the TBTA relay can operate. If the TBTA relay operates, it operates the FM relay causing the RAV1 relay to operate to release the marker.

B2-2.9.3 All Registers Busy Timing on Test Calls

There are several variations in all registers busy timing on test calls because of controls imposed on selection of trunk link frames and of ORs with certain keys operated as described in SCD-B2-1.7 and B2-2.10.

- (a) On any test call, the MT1 and MT11 relays operate. The MT1 relay opens the operate path of the FTCK relay (SFD-B206) giving the MTC control of when or whether it operates. Thus, while FTCK and FTCK1 both operate at the same time on service calls, the operation of the FTCK may be delayed on some test calls. When the FTCK1 relay operates on a test call, the TBT relay remains operated via the MT11 relay contacts until the FTCK relay operates.
- (b) On test calls with the NTFS keys operated, the MT9, MT19, and MT29 relays of the DTM operate from the operated KMT9 relay of the MTC (SFD-B202). The operated MT9 causes the marker to select a TL as directed by the MTC whether or not there are any ORs available on the TI (SCD-B2-1.7.3). On test calls with either the FS or NTFS key operated, the MT5 relay of the DTM operates (SFD-B209). This causes the DTM to select only that OR on a TL corresponding to the operated TT- key or setting of the TSU switch. Under any of these conditions the marker does not know that there is

an idle OR available on the TL until it actually selects one. For this reason, the TBT relay is reoperated after the MAK1 and TBK relays have operated (SFD-B204), indicating that the trunk link connector relays and trunk link TB- relays have operated. The TBT relay remains operated until the TSE1 relay operates as an indication that an OR has been selected. Since the MAK1 relay is operated, the timer functions to operate the TBTA after an interval of 1.0 to 1.5 seconds with the Mfr Disc. option or after 120 to 185 ms with the standard option.

B2-2.10 CONTROL OF ORIGINATING REGISTER SELECTION BY THE MASTER TEST CONTROL CIRCUIT (SFD-B209, B210)

Three modes of controlling originating register selection by the master test control circuit are provided on DT (dial tone marker) and OR (originating register) test calls.

- (a) Normal selection (TS and NTTS keys normal)
- (b) Selection of a particular register when it is not maintenance busy (TS key operated)
- (c) Selection of a particular register whether it is maintenance busy or not (NTTS key operated).

B2-2.10.1 TS and NTTS Keys Normal

With the TS and NTTS key normal, the MT5 and MT6 relays in the dial tone marker do not operate (SFD-B208). The marker selects originating registers in the normal manner as on service calls.

B2-2.10.2 TS Key Operated

With the TS key operated along with the TT0-9 key or the TSU switch, the MT5 and MT6 relays of the dial tone marker are operated and the TSE2 relay which normally operates in parallel with the TSE1 relay is prevented from operating by the operated MT1 relay of the DTM and the KTS relay of the master test control circuit (SFD-B209).

Windings of TT- relays of the DTM are now not supplied with battery from the TSE2 relay. Instead they are extended back to the MTC which supplies battery only to that TT0-9 lead corresponding to the TSU switch position or TT- key operated. The operated MT6 relay in conjunction with the TSU switch position or operated TT0-9 key closes an operate path to only the ETS relay if set to an even number or to the OTS if set to an odd number. The DTM therefore can detect as idle and select only that register corresponding to the TSU switch position or the operated TT0-9 key.

B2-2.10.3 NTS Key Operated

With the NTS key operated, control of originating register selection by the marker is the same as described for the TS key operated. However, in addition, the TST relay in the trunk link frame is operated (SFD-B209). Ground for make-busy jacks for all the originating registers on each trunk link frame is supplied through a back contact of the TST relay for each trunk link frame. When the TST relay operates, all originating registers which are made busy on that trunk link frame are restored to service. (The MB relay releases.) It is, therefore, possible to select a particular originating register which is maintenance busy.

The maintenance busy condition is removed only during the time that the marker engaged on the test call is connected to the trunk link frame. No other DTM, therefore, can select the maintenance busy originating registers for service calls.

B2-3 ROUTE ADVANCE AND RECYCLE

The term "route advance" applies more to the CM than to the DTM. It is a carryover to the DTM from the time when there was a single combined marker incorporating the features of both the DTM and the CM. In the CM when all trunks via one route are busy, the CM route advances to trunks via a different route to the same destination or to tone or other miscellaneous trunks.

When the DTM finds all ORs busy, the FM relay is operated by the TBTA relay (SFD-B415). The FM relay in turn operates the route advance RAV1* relay (SFD-B206). The RAV1 relay operates the DIS1,2 relays (SFD-B502) causing the DTM to release. Since the line in this case would still be off-hook, a new request for dial tone would be initiated.

Recycles as a result of all channels busy also result in operation of the RAV1 relay if no channel is found after the second recycle. This is described in SCD-B4-1.18 and B41-19.

* Some offices have all register busy announcement trunks. In these offices, the RAV1 relay causes a route advance to the announcement trunks whenever all ORs are busy. This SFD and SCD do not cover announcement trunks.

B2-4 CROSS-DETECTION INDICATIONS (SFD-B207)

Numerous cross-detection relays are shown throughout the SFD. Each of the cross-detection relays in operating either operates the MXT relay directly or operates an auxiliary relay which operates the MXT relay (SFD-B207). The MXT relay operates the SP (stop progress) relay (SFD-B502) which opens the operate paths of a number of relays causing a work time-out.

There is an MXT designation on both of the double-sided cards, but not on the single-sided card.

Although most of the cross-detection trouble indicating leads are shown on pages with cross detection relays, all of these leads are repeated on SFD-B207.

SECTION B, PART 3

CONNECTION TO LINE LINK FRAME

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B3 CONNECTION TO LINE LINK FRAME

In establishing a dial tone connection, a line link frame LL connects to a dial tone marker DTM via an associated line link marker connector LLMC as described in SCD-B1. The LLMC closes through most of those leads required exclusively for the dial tone connection. After the DTM has seized a TL, it bids for access to the same LL via the associated line link connector (LLC). The LLC primarily closes through leads which are required for completing marker CM functions as well as for DTM functions. Although the leads necessary for vertical file identification are not closed through until connection through the LLC is established, vertical file identification is described in SCD-B1 to present all line location identification together.

B3-1 LINE LINK FRAME SEIZURE (SFD-B004, B302, B303)

The operation of the TFK1 relay in the DTM, indicating successful TL seizure, closes battery to the LFS lead (SFD-B302) through the associated LLMC (SFD-B303) to the ST lead of the preference control, PC.

B3-1.1 PREFERENCE CONTROL CIRCUIT

The preference control associated with line link connectors provides two preference relays, MP- (marker preference) and E- (emergency marker preference), per marker for each line link connector. There is a means for detecting trouble associated with both the MP- and the E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by two chain circuits, which enable connection of one marker at a time to a line link frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to E- relays.

B3-1.1.1 MP- Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a LL), MP- relay operation is straightforward. Start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP-operated chain to ground at the winding of the first relay in the operate chain (shown on B303 as associated with the last DTM). In periods of heavy traffic, two or more markers may initiate requests either simultaneously or in rapid succession.

Assume that the first CM and first DTM (SFD-B303) initiate simultaneous requests (apply start battery) for connection to the same LL. Both MP-relays will operate and lock. If, however, the first DTM had initiated

a request slightly before the first CM, the MP- relay for the first CM could not have operated because ground for its winding would have been opened by the operated chain at the MP- relay for the first DTM. On the other hand, if the first CM initiated a bid first, any other marker ahead of it in the operate chain can subsequently operate its MP- relay.

B3-1.1.2 MP- Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, a work chain determines which MP- relay does the work. The work chain progresses through contacts of the MP- relays in the opposite direction to the operate chain starting with ground at a contact of the MP- relay for the first CM. If the MP- relay for the first CM is operated, the work chain ground will operate the M- line link connector relay whether or not other MP- relays are operated. The M- relay operates other M- relays in the connector (SFD-B302) by closing through battery supplied by the marker.

When the marker which has seized the LL has finished its job and opened the start lead to the PC, its MP- relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated, now functions as just described. This continues until all operated MP- relays have been served.

B3-1.1.3 Emergency Transfer

Same as B2-1.5.1.3 except for references.

B3-1.1.4 Manual Transfer

Same as B2-1.5.1.4 except for references.

B3-2 CLASS-OF-SERVICE IDENTIFICATION

Originally, No. 5 Crossbar was arranged for a maximum of 30 classes of service, wherein the DTM received class of service from the LL by ground on 1/30 leads. Later two more leads, CGA and CGB were added to increase the number of classes to 60. In this case one out of the original 30 and one of the added two leads were grounded to provide two groups of 30. Still later, the present standard arrangement was substituted. This arrangement grounds one of the first 10 leads CS0-9 as class tens and one of the second 10 leads CS10-19 as class units, thus using 20 leads to provide 100 classes of service. The third group of 10 leads CS20-29 and the CGA and CGB leads are used to provide 20 rate treatment classes.

In a very few offices the original 30 class-of-service arrangement was modified to provide 20 classes of service and 20 rate treatment classes (using the first 20 leads CS0-19 on a 1/20 basis for class of service and using the CS20-29 and CGA, CGB leads to provide two groups of 10 rate treatment classes).

The 20, 30, and 60 class-of-service arrangements are basically the same and are shown on SFD-B304. The tens and units class of service and rate treatment arrangement for a maximum of 100 classes of service is shown on SFD-B305. For a description of the use that the DTM makes of class of service and rate treatment information, refer to SCD-B4-3.3, B4-3.4, and B4-3.5.

B3-2.1 LINE LINK FRAME CROSS-CONNECTIONS

At the right of SFD-B304 and SFD-B305 the cross-connections required for various classes of service and rate treatment arrangements are shown.

B3-2.1.1 30 Classes of Service - Identification by Vertical File

When the FTK1 relay of the DTM operates as a check of vertical file identification (SFD-B107), it closes the V- lead to ground a V- terminal in the LL (SFD-B304). This is cross-connected to a CS0-29 terminal causing one of the CS0-9 relays to operate and one of the CT0-2 relays to operate. If any of the leads CS0-9 are grounded, the CS- relay operates on its primary winding and the CT0 relay operates in parallel. A CS10-19 lead grounded would operate a CS- relay on its secondary winding and operate the CT1 relay and so on.

When a trouble record is taken, the CS0-29 leads cause similar designations to be perforated on the trouble card except for 2/X trouble cards. When 2/X trouble record cards are used, there is a conversion in the MTFC to class tens CTS0-2 on a 1/3 basis and class units CSU0-7 on a 2/5 basis.

B3-2.1.2 60 Classes of Service - Identification by Vertical File (SFD-B304)

The previous description applies also for 60 classes of service except a cross-connection from the VC- terminal of the LL to either the CA or the CB terminal instead of to ground causes either the CGA or the CGB relay in the DTM to operate in series with the VGB- relay.

The CGA or CGB relay operates the CGA1 or CGB1 relay (SFD-B429), which causes a CGA or CGB designation to be perforated if a trouble record card is taken.

B3-2.1.3 20 Classes of Service - Identification by Vertical File
(SFD-B304)

The description for 30 classes of service (SCD-B3-2.1.2) applies except that only leads CS0-19 are used for the 20 classes. A cross-connection from VR0-4 to CS20-29 causes one of these leads to be grounded to operate one of the relays CSR0-9. Another cross-connection from VRG0-4 to CA or CB causes CSGA or CSGB to operate.

When a trouble record is taken, the CS0-29 leads are perforated as described in SCD-B3-2.1.2. The grounded rate treatment lead CS20-29 causes a similarly designated punch except on the 2/X trouble card. The MTFC converts CS10-19 in this case to RTE0-7 on a 2/5 basis. The operated CSGA or CSGB relay causes a CGA or CGB punch (SFD-B429).

B3-2.1.4 100 Classes of Service - Identification by Vertical File
(SFD-B305)

The 100 class-of-service arrangement is the standard and is now used even though equipment is not necessarily provided for the maximum of 100 classes.

When the FTK1 relay of the DTM operates as a check of vertical file identification (SFD-B107), it closes the V- lead to ground several terminals in parallel but through diodes to prevent backup of ground from one terminal to another. Since class indication from the LL is on a tens and units basis, two cross-connections are required. VT0-4 is cross-connected to CS0-9 to cause one of the relays CST0-9 to operate for class-of-service tens. VU0-4 is cross-connected to CS10-19 to cause one of the relays CSU0-9 to operate for class of service units.

Where rate treatment is provided, VR0-4 is cross-connected to CS20-29 to cause one of the relays CSR0-9 to operate for rate units. VRG0-4 is cross-connected to CA or CB to operate CSGA or CSGB for rate group.

If a trouble record is taken, except for the 2/X card, 3 punches will appear in the CS0-29 designation CS0-9 for class tens CS10-19 for class units and CS20-29 for rate treatment units where provided. For the 2/X trouble card, the MTFC converts CS0-9 to CST0-7, CS10-19 to CSU0-7 and CS20-29 to RTE07 on a 2/5 basis. The CSGA or CSGB relay causes a CGA or CGB punch (SFD-B429).

B3-2.1.5 Identification of Class of Service by Hold Magnet (SFD-B304, B305)

Where identification of class of service is provided on an individual hold magnet basis rather than on a vertical file basis, the V0-4 or VU0-4 terminal is cross-connected to the VFA, VFB, or VFC terminal to operate a VFA, B, or C relay. The HMC terminal is cross-connected to a CS0-29 terminal for 30 or 60 classes, to CS0-19 for 20 classes or to CS10-19 for 100 classes.

If rate treatment is provided, it also may be identified on a hold magnet basis where class of service is so identified by cross connecting from HMRO-9 to CS20-29.

B3-3 CONTROL OF CLASS OF SERVICE BY MASTER TEST CONTROL ON DT AND OR CLASSES OF TEST (SFD-B304, B305)

Because offices may be equipped with any of several class of service and rate treatment arrangements, there are necessarily a number of optional arrangements provided in the MTC for controlling class of service and rate treatment. On a DT or OR class of test when the keys or switches for selecting class of service and rate treatment are in normal or off position, the DTM functions as on a service call to obtain the class of service (and rate treatment if provided) from cross-connections in the LL. When keys or switches are operated to select class of service or rate treatment,* this prevents the DTM from obtaining class of service (and rate treatment if provided) from cross-connections in the LL.

The ground from the marker which is normally steered through line link cross-connections is instead steered through class of service and rate treatment keys of the MTC. Use of these keys to control class of service is intended for use on OR class of test, so that any desired class of service may be set in the DTM for subsequent transfer to the OR.

B3-3.1 30 OR 60 CLASSES OF SERVICE (SFD-B304)

On test calls, the MT11 relay in the DTM is operated. This opens the normal path through which the DTM supplies ground over a V- lead to the LL to determine class of service from cross-connections in the LL.

When the CST- keys or CST switch are in the off position, the KCS0, 1, and 2 relays are normal and bridge the M11 break-contact in the DTM to permit normal determination of class of service from cross-connections in the LL.

When a CST- key or the CST switch is operated to 0, 1, or 2 on a DT or OR class of test, the KCS0, 1, or 2 relay, respectively, is operated. When the FTK1 relay operates, ground via the CSG2 lead is steered through an operated KCS- relay contact and through an operated CSU- key or the CSU switch in position 0-9 and again through contacts of an operated KCS- relay to one of the CS0-29 leads corresponding to the keys or key and switch operated.

* In some of the older MTCs which have not been updated, class of service and rate treatment keys are not effective on DT class of test. See option D on SFD-B304, B305.

B3-3.1.1 60 Classes of Service (SFD-B304)

When there are 60 classes of service, in addition to the control described above, the MT1 relay which is operated on marker test calls connects the CGA and CGB relay windings in the DTM from the CGA and CGB leads to the CGA1 and CGB1 leads to the master test control. It should be noted that when 60 classes of service are provided, option D (SFD-B304) must be provided. This causes KCS4 to operate on both DT and OR class of test.

The CGB key normal connects the CGA relay to both the CGA and the CGB leads. The CGB key operated connects the CGB relay of the DTM to both the CGA and the CGB leads. Thus, the CGB key position determines whether the CGA or CGB relay of the DTM operates in series with the VGB-relay of the LL regardless of whether the particular VGB-relay VC-terminal is cross-connected to the CA or the CB terminal.

No provision is made for verifying on DT class of test that the cross-connections between VC- and CA or CB terminals are correct.

B3-3.2 20 CLASSES OF SERVICE WITH RATE TREATMENT (SFD-B304)

This is a feature provided in very few offices. Class of service functions as previously described for classes 0-19. The CST2 key or the 2 position of the CST switch is disabled. Instead keys CRU0-9 or the CRU switch are provided.

When the CST- keys or the CST switch and the CSGA and CSGB keys are normal, the KCS0, 1, and 2 relays remain normal. The CS-, CT-, CSR-, and CSGA/B relays of the DTM operate as on a service call from cross connection in the LL.

To control class of service and rate treatment settings in the marker, the CST- keys or CST switch, the CSU- keys or CSU switch, the CRU- keys or CRU switch, and the CSGA/B keys must be set as required. Classes of service 0-19 are controlled as described. The CRU- keys or the CRU switch in any off-normal position cause operation of the KCS2 relay which disconnects the CSG1 lead from the CSG2 lead and extends the CSG2 lead ground to operate one of the CSR- relays in the DTM. Similarly, the operated CSGA or CSGB key extends the CSG2 lead ground to operate the CSGA or CSGB relay of the DTM.

B3-3.3 100 CLASSES OF SERVICE (SFD-B305)

On test calls, the MT11 relay in the DTM is operated. This opens the normal path over which the DTM supplies ground over a V- lead to the LL to determine class of service from cross-connections in the LL. When

the CST- keys or CST switch, the CSU- keys or CSU switch, and the CRU- keys or CRU switch are in the normal or off position, the KCS0, 1, and 2 relays are normal. This bridges the MT11 contacts in the DTM to permit normal determination of class of service and rate treatment from cross-connections in the LL.

To control the setting of class of service and rate treatment in the DTM, the CST keys or CST switch, CSU- keys or CSU switch and, if provided, the CRU- keys or CRU switch should be set as desired. This operates the KCS0, 1, and 2 relays to extend the CSG2 lead ground to one out of ten of the CS0-9, CS10-19, and CS20-29 leads to operate a CST-, CSU-, and CSR- relay, respectively, in the DTM. When rate treatment is provided, the CSGA or CSGB key should also be operated. This extends the CSG2 lead ground to operate either the CSGA or CSGB relay of the DTM.

B3-4 LINE LINK FRAME LOCKOUT

When a LL has seized a DTM via its LLMC, it is possible that a CM may seize the LL via its LLC before the DTM can seize the LLC. If the CM is setting up a connection from a calling line to a trunk, it must release the connection already established from that line to an OR before it can set up a new connection from that line to a trunk. When this occurs, the L relay for that line reoperates momentarily. The DTM must be prevented from attempting to identify this operated relay as a request for dial tone. If a CM has connected to a LL before there is a request for dial tone in the LL, the LL is prevented from requesting a DTM until the CM has released the LLC.

B3-4.1 SEIZURE OF DTM VIA LLMC BEFORE CM SEIZES LLC (SFD-B306)

If a LL has connected to a DTM via a LLMC but a CM connects to the same LL via a LLC before the DTM does, the DTM is not permitted to proceed with horizontal group selection until the CM has completed its use of the LLC.

Whenever any VGS- relay operates in a LL, it operates the DT relay (SFD-B306) as an indication that there is a request for dial tone. If a CM seizes the LLC for that LL to establish a connection from a calling line to a trunk, its CB2 relay will be operated. The CB2 relay operates the LOT relay (SFD-B306). When the CM proceeds to the point of operation of the TCHK relay, it grounds the G lead toward the LL via the LLC. If the DT relay is operated in the LL, the ground is extended over the DTK lead to operate the DTK relay in both the CM and the DTM. Operation of the DTK in the DTM opens the operate path of the HGG relay (SFD-B109) on first trial calls. This prevents horizontal group selection, if not already completed, by the DTM until the CM has released the LLC.

The release of the HGG relay opens the HGT- leads (SFD-B109) preventing horizontal group selection. If, however, horizontal group selection had been completed before the DTK relay operates, the HGG relay would have already been released by the operation of the HGK relay and the operation of the DTK relay would have no effect. On second trial calls, the operated TR2B cancels the effect of the DTK relay by closing through the path to the HGG relay around the break contacts of the DTK relay. Later in the call when the TK relay operates, it grounds a G lead to operate the DTK relay (SFD-B306) as a check that the DT relay of the LL has operated. This check is bypassed on second trial calls by the operated TR2A relay which allows the DTK relay to operate locally.

B3-4.2 SEIZURE OF LLC BY CM BEFORE THERE IS A REQUEST FOR DIAL TONE IN THE LL

If a completing marker, setting up a connection from a calling line to a trunk, seizes a LLC and has proceeded to operation of its TCHK relay before a request for dial tone has operated the DT relay in the LL, the LL is prevented from requesting a connection to a DTM until the CM has released the LLC.

When the CB2 relay of the CM operates, it operates the LOT relay (SFD-B306). When the TCHK relay operates, ground on the G lead through the normal DT relay in the LL operates the LO relay in the LL. The LO relay operated opens start battery to the MSA and MSB terminals (SFD-B102) preventing a request for a DTM. Operation of the LO relay also prevents operation of the TM and TM1 relay when a VGS- relay operates, so that the TM timer (SFD-B106) does not start until the LO relay releases.

B3-4.3 CROSS-DETECTION

Whenever the LOT relay of the CM is normal, the XLO relay is connected to the LOK, G, LO, and LOB leads (SFD-B306). If the XLO relay operates, it locks and causes a trouble record showing an XLO punch.

B3-4.4 SIMULATION OF DT RELAY OF LL BY MTC

On a DT or OR class of test, the DTK lead is connected to the G lead (SFD-B306) to simulate an operated DT relay in a LL.

SECTION B, PART 4
NETWORK CONNECTION AND TRANSMISSION OF
INFORMATION TO ORIGINATING REGISTER

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B4 NETWORK CONNECTION AND TRANSMISSION OF INFORMATION TO ORIGINATING REGISTER

When the dial tone marker has identified the calling line location and has selected an originating register, it proceeds to establish a connection through the switching network from the line to the originating register. It also transmits line location and other information to the originating register.

B4-1 CHANNEL SELECTION (SFD-402-415)

A tip, ring, and sleeve path through the network is designated a channel. A channel consists of three parts:

- (a) A line link is that part of the channel between a horizontal of a line switch and a horizontal of a line junctor switch on the line link frame.
- (b) A trunk link is that part of a channel between a vertical of a trunk junctor switch and a vertical of a trunk switch on the trunk link frame.
- (c) A junctor is that part of a channel between a vertical of a line junctor switch and a horizontal of a trunk junctor switch.

The distribution of line links on the line link frame and of trunk links on the trunk link frame is uniform for offices of all sizes. The distribution of junctors however varies with the size of the office.

B4-1.1 JUNCTOR SEQUENCE CONTROL (SFD-B404, B405)

The junctor sequence walking circuit advances at the end of each call and is used to shift the order of preference for the following functions:

<u>Function</u>	<u>SFD</u>
Vertical Group Selections	B108
Horizontal Group Selections	B109
Vertical File Selections	B109
Trunk Selection	B209
Junctor Group and Pattern Tens Selection	B403, B407

The junctor sequence walking circuit is shown on SFD-B405. A sequence chart showing the advance of the walking circuit on successive calls is shown on SFD-B404.

When the D, MF, or MLF relay operates at the beginning of each call, it operates the RYC relay which in turn operates the LLC1,2 relays (SFD-B205). If the sequence circuit is in an even position (JSQ0,2 or 4 and JLO operated), the LLC2 relay operates the JS0 relay which locks. When the LLC2 relay releases at the end of the call or when the RYC relay releases because of a recycle or route advance, the next higher-numbered odd JSQ- relay operates, and, in turn, operates the JLE relay. The JLE relay releases the JSQ-, JLO, and JS0 relays. Similar operation occurs when stepping from an odd to an even JSQ- relay.

Six steps of control for preference circuits are provided by the JSQ0-5 relays. This number is doubled by the operation of the SQ0 and SQ1 relays. If the SQ1 relay is normal when the JSQ0 relay operates, the SQ0 relay operates. If the SQ1 relay is operated when the JSQ0 relay operates, the SQ0 relay releases. Similarly, the SQ1 relay is operated or released depending on the conditions of the SQ0 relay when the JSQ2 relay operates. The SQ0 relay is operated for one complete cycle of the walking circuit, then released for one complete cycle. The same applies to the SQ1 relay. However, since the SQ0 is operated and released by JSQ0, and SQ1 is operated and released by JSQ2, there are steps during which SQ0 and SQ1 may both be operated or both released.

The SQA relay monitors operations of the junctor sequence walking circuit. If the SQA relay operates as a result of trouble in the walking circuit, it operates the MXT relay which causes a trouble record to be produced showing an SQA trouble punch.

The following conditions cause operation of the SQA relay which is slow operate to prevent false operation due to momentary closures as relays change conditions. The SQA relay operates the MXT relay which operates the TR1 relay to cause a trouble record to be taken showing an MXT* and an SQA punch.

Trouble conditions detected between calls (LLC2-normal) occur when:

- (a) Both JLE and JLO are normal.
- (b) Both JLO and JS0 are operated.
- (c) Both JLE and JSE are operated.

* There is no MXT designation on the single-sided card.

Trouble conditions detected during calls (LLC2 operated) occur when:

- (a) JLO is operated and JSO is normal.
- (b) JLE is operated and JSE is normal.
- (c) SQ0 and SQ1 are both operated or both are normal when JSQ1 is operated.
- (d) SQ0 is operated and SQ1 is normal or SQ0 is normal and SQ1 is operated when JSQ3 is operated.

When the fuse which supplies battery to the walking circuit is inserted, the SQA relay will operate because the JLE and JLO relays are both normal. When the SQA relay operates, it operates the JSQ0 relay which operates the JLO relay which should release the SQA relay if there is no trouble in the walking circuit. This will cause a trouble record to be taken which will show an MXT* punch but no SQA punch unless the SQA remains operated because of trouble.

B4-1.1.1 Control of Junctor Sequence by the Master Test Control on a DT Class of Test (SFD-B404, B405)

On a DT class of test with the JSQ- keys or switch in the off or normal position, there is no control of the junctor sequence walking circuits. It advances in the normal manner at the end of the test call or if a recycle or route advance occurs.

Refer to sequence chart for test call (SFD-B404 to SFD-B405). With JSQ- keys or switch operated, ground from the operated KCH relay of the MTC operates the MT8 relay of the DTM through the operated MT relay. The MT8 relay operates the MT8A relay. The operated MT8 relay opens the locking path to release any operated JSQ- relay and either the SQ0 or SQ1 relay. The release of the JSQ- relay releases the JLE or JLO relay. With both JLE and JLO relays normal, the ground that would normally operate the SQA relay as a trouble condition is transferred by the operated MT8 relay to operate the KJSQ relay of the MTC which locks and transfers the operate path of the MT8 relay of the DTM to ground on the KJSQ lead through the JLE and JLO relays normal. The operated KJSQ relay provides a ground through the JSQ- key of switch to operate the desired JSQ- relay in the DTM. The JSQ- relay operates the JLE or JLO relay. This releases the MT8 and MT8A relays and operates the MC relay of the MTC. The marker junctor walking circuit has been advanced to the desired position and will advance in the normal manner at the end of the call or if there is a route advance or recycle. If JSQ1 step is selected, the SQ0 relay operates. Otherwise SQ0 and SQ1 remain normal for the test call.

* There is no MXT designation on the single-sided card.

B4-1.1.2 Check that Necessary Test (MT-) Relays Have Operated in the DTM

On every test call the MTC verifies that the necessary test (MT-) relays have operated in the marker. Some MT- relays in the marker always operate on test calls. Others only operate when certain keys of the MTC have been operated. A satisfactory verification results in operation of the MC (marker connect) relay of the MTC. The MC relay operates various MC- and K- relays to close through leads either directly or via the MTFC to the DTM. If the check for operation of the MT- relays fails, the test call is blocked.

Table E shows test relays operated and those which are checked in DTM with various test keys operated.

TABLE E

Test Keys or Switches Operated	Relays Operated	Relays Operated	Relays Checked Operated
DT/OR key TSTA (DT/OR) Switch	TS-TKS KCH ¹	MT, MT1, 2, 11 13, 15	MT, MT1
FS		MT4, 14, 24	MT4, 14, 24
NTFS		MT9	MT9
JSQ- key or switch		MT8, MT8A	MT8A

NOTE 1: In some older test frames, KCH relay does not operate on OR class of test.

NOTE 2: Checked operated then released.

When the TS, NTTS, FS, and NTFS keys and the JSQ- keys or switch are normal, ground from the MT1 relay of the DTM passes through normal contacts of the FS and NTFS keys and through normal contacts of the MT8 and MT8A relays of the marker, then through normal contacts of the JSQ- keys or switch and the TS and NTTS keys normal to operate the MC relay. If either the TS or NTTS keys are operated, the KTS relay (see SFD-B208) must have operated. If the FS key is operated, then the MT4, 14, and 24 relays if provided in the marker must operate (SFD-B202). If the NTFS key is operated, the MT9 relay of the marker must operate. If the JSQ- key or switch is operated on a DT class of test [or on an OR class of test with the standard option to operate the KCH relay (SFD-B405)], the MT8 and MT8A relays of the DTM must operate then release as described in SCD-B4-1.1.1 to operate the MC relay.

B4-1.2 OFFICE SIZE - TRUNK LINK FRAMES (SFD-B405)

A cross-connection in each DTM from the SZD terminal (SFD-B405) to one of the terminals SZ2-10 indicates the size of the office in terms of number of single trunk link frames in a nonpaired office, number of pairs of trunk link frames in a paired office, or number of trunk link frame triples in a triple office.

During transition from one size office to another, some trunk link frames may have junctor configurations for one size office while others have other size office junctor configurations. In this case, the SZA, SZB, and SZC terminals are cross-connected to appropriate SZ2-10 terminals in each marker, and the G terminal of each trunk link frame is cross-connected to SZA, SZB, or SZC terminals as required. These cross-connections are changed in individual trunk link frames as the transition progresses. Upon completion of the transition, the SZD terminal of each DTM is cross-connected to the SZ2-10 terminal corresponding to the new office size.

B4-1.3 SINGLE, PAIRED, OR TRIPLE TRUNK LINK FRAME OPERATION (SFD-B408)

A cross-connection in each DTM from the SPF terminal to the SF, PR, or TTF terminal indicates to the DTM whether the office is arranged for single, paired or triple trunk link frame operation. During transitions, however, from single to paired or paired to triple trunk link frame operation, the marker cross-connections are removed and instead cross-connections are made in each TLC. A frame which has not been modified might be cross-connected as a single (STF) trunk link frame while another frame which has been modified might be cross connected as a paired (PR) trunk link frame.

B4-1.4 OFFICE SIZE - LINE LINK FRAMES (SFD-B408)

The marker determines office size in terms of number of line link frames from a combination of the office size in terms of trunk link frames (SCD-B4-1.2) and the indication of single, paired, or triple trunk link frame operation (SCD-B4-1.3) (see SFD-B408). The 20F relay operates for 20 or less line link frames, the 40F relay for 21-40 line link frames, and the 60F relay for 41-60 line link frames.

B4-1.5 PATTERN UNITS (SFD-B402)

In the following size offices all junctor subgroups have 10 junctors.

2TLF	Single, paired, or triple*
2-3TLF	Single, paired, or triple

* Paired or triple 2TLF-size offices require operation of pattern units relays.

5TLF	Single, paired, or triple
10TLF	Single, paired, or triple

All other sizes have some junctor subgroups with less than 10 junctors.

To determine which junctors are equipped, 1 of 10 pattern units (P0-9) relays is operated in the DTM. SFD-B402 shows how a particular pattern units relay is operated for TLO in an office having single TL operation. It also shows particular pattern units relay operation for either TL of TL pair 0 in an office having paired TL operation. The choice of pattern units relay is determined by the line link frame number FUT0-9 relay and FTB0-3 relay operated and the line link office size relay 20F or 40F operated.

B4-1.6 NUMBER OF JUNCTOR SUBGROUPS (SFD-B407)

This applies only to 6TLF and 7TLF size offices. Both of these office sizes have some junctor groups with two and other junctor groups with three junctor subgroups. With either of the relays 6TLF or 7TLF operated, relays P0,2,3 and 4 operate the 3G (3 junctor subgroup) relay while relays P4-9 operate the 2G (2 junctor subgroup) relay.

B4-1.7 QUAD RELAYS (SFD-B408)

The seven quad (7Q) relay is used only in paired or triple trunk link frame offices of the 7 TLF size. The regular quad relay (RQ) is used only in paired or triple trunk link frame offices of 6TLF, 8TLF, or 9TLF sizes. The term "quad" no longer has a valid meaning since triple trunk link frame operation came into use. Essentially, these relays provide a convenient and more economical method of steering the JC-leads (SFD-B411) than by using contacts of -TLF relays for the particular size offices.

B4-1.8 PATTERN TENS* (SFD-B403)

The PNR relay is always operated by the following office sizes which have no subgroups of less than 10 junctors.

2TLF	Single, paired, or triple
2-3TLF	Single, paired, or triple
5TLF	Single, paired, or triple
10TLF	Single, paired, or triple

* Sometimes referred to as pattern groups.

The PNR relay is also operated for certain other office sizes when the marker is directed by the operated or released condition of the STP1, STP2, and JSQ- relays to junctor subgroups having 10 junctors. When the marker is directed to subgroups having less than 10 junctors, one of the pattern tens relays PA, PB, PC, or PE is operated.

B4-1.9 TEST CHANNEL RELAYS - TEST CHANNEL CHECK (SFD-B412, B415)

The marker determines what channels are equipped in a subgroup by operating the TCH0-9 relays (SFD-B412) from contacts of the operated PNR relay which operates all ten relays or from contacts of a combination of one pattern tens and one pattern units relay which operates only those TCH- relays corresponding to equipped junctors.

The operation of any TCH- relay operates the TCHK relay (SFD-B415) which locks to the GC or to the GCA relay.

B4-1.10 JUNCTOR SUBGROUP SELECTION (SFD-B406, B407)

To simplify the path for operation of the JG relays, SFD-B406 shows operate paths for offices with 2, 2-3, 5, or 10TLF-size while SFD-B407 shows operate paths for all other sizes 3, 4, 6, 7, 8, and 9. Note on SFD-B406 that only the JG0 relay can be operated for 10TLF-size since there is never more than one junctor subgroup. For the 5TLF size either JG0 or JG1 relay may be operated. For the 2-3TLF-size JG0 or JG3 relays may be operated while for the 2TLF size JG0-JG4 relays may be operated. Since no pattern units relay is required for these office sizes, the 1 out of 10 check of the P- relay is bypassed.

Office sizes 3, 4, 6, 7, 8, and 9TLF each have one or more junctor subgroups with less than 10 junctors and therefore must operate pattern units relays. Ground for operating the JG- relays is provided through a 1 out of 10 check of pattern units relays and, if the office has triple trunk link frames, a similar check through pattern auxiliary relays.

For any size office, the STP1 relay (SFD-B415) is always operated at the beginning of a call. As will be described in SCD-4-1.18, if no idle channel is available in the junctor subgroup selected through the STP1 relay, the STP1 relay will be released and STP2 relay operated to operate a different junctor subgroup, JG- relay. This applies to all sizes except 10TLF which only has one junctor subgroup.

As described in B4-1.1, the junctor walking circuit is stepped to a new position at the end of each call for office sizes have more than one junctor subgroup. Different subgroups are given preference according to which JSQ0-5 and JLE or JLO relays are operated.

B4-1.11 JUNCTOR SUBGROUP CONNECTOR RELAYS (SFD-B415, B408)

The GC [or GCA relay in some cases with triple trunk link frame operation (SFD-B415)] operates early in the call from the LLC1 relay. The operated GC or GCA relay steers battery through contacts of an operated JG0-4 relay to operate a junctor subgroup connect relay G0-4 in the trunk link connector (SFD-B408). A one out of five check through the JG0-4 relay ensures that only one relay is operated. To detect crossed G- leads to the TLC, normal JG- relays ground associated leads. If the lead associated with the operated JG- relay is crossed to any other lead, the direct ground causes sufficient current to flow through the XJG relay to operate it. The XJG relay is biased to not operate on the current required to operate the G- relay in the TLC. If the XJG relay operates, it in turn operates the XAJG relay which locks and causes a trouble record showing XJG punch to be taken.

B4-1.12 JUNCTOR CONNECT RELAYS - JUNCTOR CONNECT CHECK (SFD-B411, B417)

Junctor connect relays JC0-9 are associated with regular trunk junctor switches. Relays JC10-19 are associated with extension trunk junctor switches. Relays JC20-29 are associated with supplementary trunk junctor switches. JC0-9 leads are partially closed by the previously operated G0-4 relays in the TLC.

The path for operating the JC- relays is shown on SFD-B411. Battery is supplied through the winding of the XJC relay which is biased through its secondary winding to operate if any of the JC- leads are crossed, so that the XJC relay is connected to ground through more than one JC- relay winding. If the XJC relay operates, it operates the XAJC relay which causes a trouble record showing an XJC punch.

When the G0 relay in the TLC is operated, JC0-9 leads from the marker are closed through directly to the JC0-9 leads, respectively, to the TL. However, relays G1-G4 close the JC0-9 leads from the marker to cross-connection terminals G10-19, G20-29, G30-39, and G40-49. The cross-connections required are different for each office size and vary between TLC associated with different TL in the same office. Note 1 on SFD-B409 shows the cross-connections which would be used in an office having six pairs of TL. Refer to BSP-819-220-150 (J27651) for complete cross-connection information.

To steer the activated JC- lead to the proper JC0-9, JC10-19, or JC20-29 relays, the marker operates an RF relay EF or SEF relay (regular, extension or supplementary extension frame) (SFD-B410). Battery to operate one of these relays is fed through the winding of the XF relay which is biased to operate if the RF, EF, or SEF leads are grounded or crossed so that XF relay supplies current to more than one relay. If the XF relay operates, it operates the XAF relay which causes a trouble record showing an XF punch.

JCO relay connects to the sleeve leads of the level 0 junctors on the left and the level 0 junctors on the right of each of the junctor switches 0-9. The JCO relay also connects to the 10 level 0 select magnets, one on each junctor switch 0-9. Similarly, each of the JC1-9 relays connects to sleeve leads and select-magnets associated with levels 1-9, respectively, on each of the junctor switches 0-9. To associate with only the junctors on the right or on the left half of switches, the marker operates R*(RA), ER*(RE), and SER*(RX) relays or L*(LA), EL*(LB) and SEL*(LX) relays (SFD-B410). The ER and EL relays (extension right or left) are only required for paired or triple TL operation. The SER and SEL (supplementary extension right or left) are only required for triple trunk link frame operation. The battery to operate these relays is fed through the winding of the XLR relay. The XLR relay is biased to operate when connected to more than one relay, either L or R when the STF relay is operated for single trunk link frame offices. It is biased to operate when connected to more than two relays R and ER or L and EL when the STF relay is normal, and the PR relay is operated for paired trunk link frame offices. It is biased to operate when connected to more than three relays (R, ER, and SER, or L, EL, and SEL) when the STF and PR relays are normal in triple trunk link frame offices. It should be noted (SFD-B408) that during transitions STF or PR may be operated or nonoperated depending on which TLC is used. A TLC which has not been changed over from single to paired operation would still operate the STF relay while a TLC which had been modified would operate the PR relay.

When a JC- relay operates, the JCK relay on the JS0 lead operates to ground through one of the select magnets on the 0 junctor switch as a check that the JC- relay has operated.** The JCK winding resistance and the JCK series resistance limit the current so that although the sensitive JCK relay operates, the select magnet does not.

When R, ER, and SER or L, EL, and SEL operate, the RK or the LK (right check or left check) relay, through contacts of all three relays in series as a check to the marker that they have operated.

B4-1.13 CONNECTION TO LINKS OF HORIZONTAL GROUP ON LINE LINK FRAME (SFD-B107,B414)

Operation of the HGA-, HGB- relays of the line link frame are described in SCD-B1-6.2.8. Operation of these relays is checked by operation of the HGK relay of the DTM. The operated HGB- relay closes through LLO-9 leads to each of the ten links associated with that horizontal group (SFD-B414).

* Trunk Link Frame (SD-27879-01)

** On trunk link frame SD-27879-01, the JCK relay operation checks the operation of SA- or SB- relay.

B4-1.14 CONNECTION TO LINKS OF TRUNK SWITCH ON TRUNK LINK FRAME
(SFD-B209, B421)

Selection of an originating register and operation of its F relay and the associated FA-2 relay in the TL (SFD-B209) is described in B2-2.8. The FA-2 relay (SFD-B421) operates the LV2 relay (BT leads on trunk link frame SD-26032-01 were hard wired and originating registers were assigned to LEV2)[†]. The FA2 relay also closes the path to operate an LC-relay which is the same number as the trunk switch on which the originating register has an appearance. When an LV- and FA- relay have both operated, the marker gets a check indication by operation of its FAK relay. It also gets a check indication that an LC- relay has operated by operation of the LCK relay. The operated LC- relay connects to sleeve leads of the 20 links associated with the trunk switch on which the originating register appears (SFD-B414). The operated L or R relay closes through ten sleeve leads associated with the left or right half of the trunk switch.

B4-1.14.1 Trouble Shooting Crosses in Multiple to FA- Relays in
Operate Path of LC- Relays (SFD-B421)

In normal operation, contacts of LV- relays in the operate path of LC-relay (SFD-B421) are strapped. This reduces marker holding time by allowing the LC- relay to operate earlier. However, in this condition the ALC lead is multiplied to over 100 FA- or FB- relays. In the event of a cross on this multiple, removal of straps around the LV- relay contacts break the multiple into ten separate parts to make trouble shooting easier while still permitting the TL to handle traffic with a slight increase in marker holding time. The straps should be replaced after the trouble is cleared.

B4-1.15 CHANNEL TEST (SFD-B414)

Ten channel test relays CHT0-9 are connected through diodes to ten line link sleeves, ten junctor sleeves, and ten trunk link sleeves (SFD-B414). Diodes in each lead prevent a ground on one leg of a channel such as a line link feeding through to another leg of the channel such as the junctor or trunk link while at the same time permitting a ground on the sleeve of any of the three legs to operate the associated CHT-relay. The test paths for the 0 channel are shown in red on SFD-B414. The STX relay (SFD-B207) operates early in the call and provides direct battery to the CHT- relay windings. Between calls the STX relay is released. If any of the channel test leads are falsely grounded to either the line or trunk link connectors, the XCH relay will operate between calls. The XCH relay operates the XACH relay which locks and causes a trouble record showing an XCH punch.

[†] On trunk link frame SD-27879-01 the BT leads (BT00-19) and the TB leads (TB0-9) may be associated with Bany location (switch, level and appearance) in the trunk link circuit.

B4-1.16 TEST CHECK (SFD-B415)

The preceding paragraphs have described a number of operations which proceed at the same time in preparation for selection of a channel. Upon successful completion of each operation, a check relay operates. These check relays are summarized below.

- TCHK - Checks that at least one TCH- relay has operated.
- JCK - Checks that a JC- relay in the TL has operated.
- RK/LK - Checks that an R or L relay in the TL has operated.
- FAK - Checks that an FA- relay and an LV- relay in the TL has operated.
- LCK - Checks that an LC- relay in the TL has operated.

When all of the previously listed relays have operated, ground over the MDK lead (SFD-B415) from the TLC operates the TK (test check) relay. The TK relay closes a G lead (SFD-B306) to the LLMC which is extended through an operated DT relay contact in the LL and back over the DTK lead to operate the DTK relay in the DTM. On second trial calls, the operated TR2A relay bypasses the G and DTK leads to operate the DTK relay directly.

B4-1.17 SELECTION OF A CHANNEL (SFD-B415)

The LLC1 relay and the SLRK relay will have operated early in the call. When the TK and DTK relays operate, ground is closed to operate a CH0-9 relay (SFD-B413). There is a double chain path composed of CHT0-9 relays and TCH0-9 relays which determines which CH0-9 relay, if any, is to be operated. Some or all of the TCH- relays (SFD-B412) will be operated as an indication of which channels are provided in the subgroup being tested. Any channel which is busy (SFD-B414) will have an operated CHT- relay. If the TCH0 relay is operated and the CHT0 relay is normal, the CH0 relay operates and locks. If, however, either TCH0 relay is normal or CHT0 relay is operated, ground is passed to operate the next relay in the chain which has an operated TCH- relay and a normal CHT- relay. When one CH- relay has operated and all others are normal, the CHA relay operates as an indication that a channel has been selected.

B4-1.18 NO IDLE CHANNEL, RECYCLE, FAILURE TO MATCH, ROUTE ADVANCE (SFD-B415)

If there is no idle channel, that is, no CH- relay having both an operated TCH- relay and a normal CHT- relay (SFD-B415), the FMP relay operates in a 10TLF-size office. In all other size offices, the STP relay operates. Refer to the flowchart (SFD-B009) and the sequence chart (SFD-B007, B008) which show the general and detailed sequence of operations under various conditions.

Operation of the STP relay causes release of the STP1 relay and various other relays in the DTM and TL which had operated in preparation for selection of a channel in Step 1. The STP2 relay then operates and an attempt is made to select a channel in Step 2.

If no channel is available in Step 2, the DTM recycles. It releases the TL and OR which had been selected and selects a new TL and OR after which it again attempts to find a channel in Step 1. If unsuccessful, it advances to Step 2 as before. If again unsuccessful, the RAV1 relay of the DTM is operated (SFD-B206). This operates the DIS1, 2 relays causing the marker to release (SFD-B502).

In a 10TLF-size office, the operation of the FMP relay causes immediate recycle without making an STP2 junctor retest since there is never more than one junctor subgroup in any junctor group in a 10TLF-size office.

B4-1.19 CONTROL OF CHANNEL SELECTION BY MASTER TEST CONTROL (SFD-B107, B202)

To select one particular path through an office, a number of controls are required.

- (a) Particular horizontal group on a particular LL. Controlled by line location keys or switches (SFD-B107, SCD-B1-8.2).
- (b) Particular trunk switch on a particular TL. Controlled by trunk link frame selection keys or switches (SFD-B202, SCD-B2-1.7) and trunk selection keys or switches (SFD-B209, SCD-B2-2.10) and D, MF, or R- keys on the RG switch (SFD-B105, SCD-B1-5.7).
- (c) Particular junctor walking circuit position. Controlled by junctor sequence keys or switches (SFD-B405, SCD-B4-1.1.1).
- (d) Particular junctor step. Controlled by STP1/STP2 keys (SFD-B413, B415, SCD-B4-1.1.19.1.2).
- (e) Particular channel. Controlled by channel selection keys or switch (SFD-B412, B413, SCD-B4-1.1.19.3)

B4-1.19.1 Junctor Step 1 Selection (CH- Key or Switch Normal) (SFD-B412, B413, B415)

To force the DTM to select a channel only in step one, the STP1 key is operated. (Refer to sequence chart for Step 1 on SFD-B413.) The STP1 key operated causes the MT7 relay of the DTM to operate (SFD-B412). When the STP1 relay of the DTM operates, the STP relay of the MTC is operated (SFD-B415). This releases the MT7 relay of the DTM and channel selection proceeds normally, if there is an idle channel. If there is

no idle channel (in other than a 10TLF-size office), there is a junctor retest (see sequence chart SFD-B007 and flowchart SFD-B009). The retest results in release of the STP1 relay of the DTM and subsequent operation of the STP2 relay. The release of the STP1 relay of the DTM releases the STP relay of the MTC (SFD-B415) which causes reoperation of the MT7 relay of the DTM. This prevents selection of any channel in Step 2 causing the marker to recycle and reselect a trunk link frame and originating register. In a 10TLF-size office failure to select a channel in step 1 causes the DTM to pass Step 2 and go directly to recycle.

The same operations are repeated after the recycle to permit selection of a channel only in Step 1. If no channel is available in Step 1, the DTM is prevented from selecting a channel in Step 2. It then route advances to disconnect.

Whenever a DTM recycles, the operation of the RCY* relay of the DTM (SFD-B206) also operates the RCY relay of the MTC which locks and lights the RCY lamp. A route advance by the DTM causes the RA1 lamp to light at the MTC.

B4-1.19.2 Junctor Step 2 Selection (CH- Key or Switch Normal)
(SFD-B412, B413, B415)

To force the DTM to select a channel only in Step 2, the STP2 key is operated. Refer to sequence chart for Step 2 (SFD-B413). The STP2 key operated causes the MT7 relay of the DTM to operate. This prevents any TCH- relay from operating and therefore no channel can be selected. In other than a 10TLF-size office, this results in a channel retest (see sequence chart on SFD-B007 and flowchart on SFD-B009). The retest results in release of the STP1 relay of the DTM and subsequent operation of the STP2 relay which also operates the STP relay of the MTC (SFD-B415). This releases the MT7 relay of the DTM. The MT7 relay normal now permits TCH- relays of the DTM to operate in normal manner, so that a channel can be selected in Step 2 if an idle channel is available. If no channel is available in Step 2, the marker recycles to reselect a trunk link frame and originating register.

Whenever a DTM recycles, the operation of the RCY relay of the DTM (SFD-B206) also operates the RCY relay of the MTC which locks and lights the RCY lamp.* A route advance by the DTM causes the RA1 lamp to light at the MTC.

* Many of the older test frames are not equipped with the RCY relay and lamp.

B4-1.19.3 Particular Channel Selection (STP1/STP2 Keys Normal)
(SFD-B412)

With the CH- keys or switch and the STP1/STP2 keys normal, there is no control of channel selection from the master test control circuit and a channel is selected at random as on a service call. With the CH- keys or switch operated, the MT7 relay in the marker operates. This opens the grounds normally used by the marker to operate TCH0-9 relays. The operated CH- key or switch provides ground on one end of the TCH0-9 leads to permit only the corresponding TCH0-9 relay to operate only if it normally would have been operated by the combination of pattern relays operated. This then restricts the marker so that it can only operate a channel relay corresponding to the operated CH- key or switch. The CH- relay can only be operated if the channel is idle (as indicated by the corresponding CHT- relay normal).

If the particular channel is not available in Step 1, the DTM makes a retest to try to find a channel in Step 2 (except in a 10TLF-size office) (refer to sequence chart SFD-B007 and flowchart SFD-B009). Again the DTM is restricted to select only the channel corresponding to the operated CH- key or switch. If no channel is available in Step 2, the DTM recycles to reselect a trunk link frame and originating register. The DTM again attempts to select the particular channel number in Step 1 then in Step 2. If the DTM cannot find that channel number idle, it route advances to disconnect. Whenever a DTM recycles, the operation of the RCY relay of the DTM (SFD-B206) also operates the RCY relay of the MTC which locks and lights the RCY lamp. A route advance by the DTM causes the RA1 lamp to light at the MTC.

B4-1.19.4 Combined Particular Junctor Step and Particular Channel Selection (SFD-B412, B413, B415)

When STP1 or STP2 key and a CH- key or switch are operated together, the DTM is restricted to selection of a particular channel within a particular junctor step. The MT7 relay of the DTM remains operated in both Step 1 and Step 2. The STP relay of the MTC is operated during Step 1 with the STP 1 key operated and during Step 2 with the STP 2 key operated. This feeds ground through the operated CH- keys or switch to permit selection of only that channel corresponding to the operated CH- key or switch.

Recycle and route advance may occur as previously described resulting in the lighting of RCY and/or RA1 lamps at the MTC.

B4-2 SELECT MAGNET OPERATION

B4-2.1 LINE LINK FRAME SELECT MAGNET OPERATION (SFD-B416)

Upon operation of a CH- relay, battery through the LS and LSA ballast lamps is closed to the select magnets on the line link frame. This battery is steered by the operated HGA- relay to the prior link select magnets and junctor hold magnets. It should be remembered that the line junctor switches also serve as line switches. One half of the verticals are for juncctors; the other half for lines. If the CH0 and HGA0 relays are operated for a line on one of the number 0 line switches to a junctor on the 0 junctor switch, an L0 and an LJ0 select magnet are operated. The LJ0 select magnet would serve a customer on the line side of the line junctor switch. If the CH1 relay and HGA0 relays are operated for a line on one of the number 1 line switches to a junctor on the 0 junctor switch, the LJ1 select magnet for the 0 junctor switch would operate, but the LJ0 select magnet on the number 1 junctor switch would also be operated to serve a line on the line side of the number 1 junctor switch.

When paired line link frame operation is provided, the select magnet leads extend to the auxiliary line link frame, even though the auxiliary line link frame is not used for dial tone calls.

The XLS relay is connected to SM- leads through normal contacts of all but the operated CH- relay. If the SM- lead through the operated CH- relay is crossed to any of the other SM leads, the XLS relay will operate to the applied battery and lock. The XLS relay operates the MXT relay which causes a trouble record to be taken showing an XLS punch.

B4-2.2 TRUNK LINK FRAME JUNCTOR SELECT MAGNET OPERATION (SFD-B417)

Upon operation of a CH- relay, battery is closed to junctor select magnets on the TL. The operated CH- relay closes an SM- lead to a junctor switch of the same number as the CH- relay. An operated JC- relay on the TL closes the SM- lead to a select magnet of the same number as the last digit of the JC- relay. JC0-9 relays are associated with the regular TL. JC10-19 relays are associated with the extension TL, and JC relays 20-29 are associated with the supplementary extension TL.

It should be noted that the JCK relay, which operated as a check that a JC- relay has operated, is released if the CH0 relay operates to apply battery to the SM0 lead. For this reason, the JCK punch will not appear on trouble cards where channel 0 is shown.

Battery to the JS- leads is fed through the XJS relay which is biased to operate if it is connected to ground through more than one select magnet. If the XJS relay operates, it operates the XAJJS relay. The XAJJS relay operates the MXT relay which causes a trouble record to be taken showing an XJS punch.

B4-2.3 TRUNK LINK FRAME TRUNK SELECT MAGNET OPERATION (SD-26032-01)
(SFD-B417)

Upon operation of the FAK relay, battery is closed to the ASM lead to operate two trunk select magnets on the TL. Since all originating registers are on the A appearance of level 2, the LV2 relay and one of the relays FA(0-9)2 will be operated. These relays steer the ASM lead to operate the TO select magnet on the switch corresponding to the first digit of the operated FA(0-9)2 relay and to operate the T2-9 select magnet corresponding to the second digit (which is always two for originating registers) of the operated FA(0-9)2 relay.

Prior to selection of an originating register, the TSE1 relay is operated. This connects the XTS1 lead to the TSX lead. If there is false ground on the lead, the XTS1 relay operates and locks. It operates the MXT relay which causes a trouble record showing an XTS1 punch.

After trunk selection, when the TSE1 relay has released and the FAK relay has operated, the XTS relay is connected to the XTS lead. The XTS relay is biased to operate if it is connected to battery through more than one T2-9 select magnet. If there is a cross which closes the ASM lead to more than one of the select magnets T2-9, the XTS relay operates and in turn operates the XATS relay which operates the MXT relay to cause a trouble record showing an XTS punch.

B4-3 FORWARDING INFORMATION TO ORIGINATING REGISTER

The DTM transmits information to the originating register which will subsequently be transmitted to the completing marker to enable it to establish a call from the calling line to whatever termination is directed by the digits which the customer dials. In preparation for transmitting this information, the following relays are operated (SFD-B428):

- GTL1 - Operated early in the call by the CKG1 relay.
- GTL2 - Operated by the GTL1.
- GTL3 - Operated after channel selection when the CHA relay operates. The GTL3 relay operation is a check that the F relay and its auxiliary F1A and F1B relays in the OR have operated. The GTL3 relay grounds most of the transmitted leads to the OR (SFD-B426, B427, B429).
- GTU - Operated by the GTL3. The GTU relay extends the FT- and FV- leads which are already grounded to the OR (SFD-B426).

B4-3.1 LINE LOCATION (SFD-B426)

Operation of the GTL3 relay grounds contacts of VGT-, HGT-, and VFT- relays to operate VG-, HG-, and VF- relays in the OR on a 2/6, 2/5, and 1/5 basis, respectively, corresponding to the relays VGT-, HGT-, and VFT- which are operated on a 1/X basis. The same grounds also operate the VGC1, VGC2, HGC1, HGC2, and VFC relays which subsequently will serve as check relays that locking ground is returned from operated relays in the OR.

Operation of the GTU relay closes the FT- and FU- leads to the OR, to operate the FT- relays in the OR on a 1/4 or 2/4 basis, and the FU- relays in the OR on a 2/5 basis.

The XVHF relay winding is connected through resistors through normal contacts of VGT-, HGT-, and VFT- relays to all VG-, HG-, and VF- leads which are not grounded by the DTM. If there is a false ground on any of these leads, the XVHF relay operates.

Operation of the XVHF (or the XCS relay to be discussed subsequently) operates the XCF relay (SFD-B428) which locks and operates the MXT relay causing a trouble record showing XCS punch.

B4-3.2 LINE LINK NUMBER AND CLASS-OF-SERVICE UNITS

The completing marker must drop the network connection from calling line to the originating register before it can establish a completing connection from the calling line. Since the original connection is still busy at the time channel test is made, the marker must know the channel number of the link used on the line link frame to be able to use it in case it is the only link available. For this reason the channel number used in setting up the dial tone connection is transmitted to the OR as LL-.

Operation of the GTL3 relay grounds contacts of the CH- relays and of CS- relays to operate LL- relays and CU- relays on a 2/5 basis in the OR and at the same time to operate check relays CLL1, CLL2, CUK1, and CUK2 in the DTM. The XCS relay functions to detect crosses as described for the XVHF relay (SCD-B4-3.1).

B4-3.3 CLASS OF SERVICE TENS, CLASS GROUP A OR B

Class of service tens originally provided for thirty classes of service and was transmitted to the register on a 1/3 basis (SFD-B427). Later, provision was made for 60 classes, CGA, and CGB information was transmitted to the OR to indicate the A or B group of 30 classes of service (SFD-B429). Still later when provision was made for 100 classes of service, class of service tens was transmitted to the OR on a 2/5 basis (SFD-B429).

For class of service tens operation on a 1/2 basis (SFD-B427), the CTL3 relay extends the already grounded CT- lead to the OR.

For class of service tens operation on a 2/5 basis (SFD-B429), operation of the GTL3 relay provides ground to contacts of the CST- relays to operate CT- relays in the CR and the check relays CSTK1 and CSTK2.

When 60 classes of service are provided, operation of the GTL3 relay provides ground to contacts of the CGA and CGB relays to operate the CGA or CGB relay in the OR and the check relays CGA1 or CGB1 in the DTM. The XCS relay also detects crosses on the class tens 2/5 leads as described for the class units and line link channel number leads in SCD-B4-3.1.

B4-3.4 RATE TREATMENT

If rate treatment is provided (SFD-B429, B option), operation of the GTL3 relay provides grounds to contacts of the CSR- relays and to contacts of the CSGA and CSGB relays to operate CRU- relays on a 2/5 basis and either the CGA or CGB relay in the OR. At the same time, the CSRK1, CSRK2, and CSGK check relays are operated. The XCS relay detects crosses on leads in the same manner described in B4-3.1 for the XVHF relay.

B4-3.5 2-PARTY, MANUAL, COIN

Operation of the GTL3 relay supplies ground which is steered through contacts of CT- and CS- relays or contacts of CST- and CSU-, CS- or CSA- relays to terminals which are cross-connected according to class assignment to the 2P, MAN, or CN terminals to operate 2P, MAN, or CN* relays in both the OR and the DTM.

When the CS- terminal is cross-connected to A0 (all other) no information is transmitted to the OR in this category.

B4-3.6 REGISTRATION AND MEMORY CHECK (SFD-B428)

The RK1 and RK2 relays are connected in series at opposite ends of a check path (SFD-B428). If all the relays associated with information to be transmitted to the OR (as described in SCD-B4-3.1 through B4-3.5) have properly operated, the RK1 and RK2 relays will operate.

* Cross-connections to 2P, MAN, CN, or A0 as shown are typical. Other less frequently used cross-connections have not been illustrated.

Note that either a 1/4 or 2/4 check of the FT- relays is made depending on the type of registration provided. A 2/5 check is made of the FU-relays while a 1/X check is made of other relays such as CS- or CSU-relays. An up check is also made of various check relays such as VGC1, HGC1,2, etc.

Operation of the RK1 and RK2 relays operates the RK3 relay from ground on a contact of the ON relay in the OR. The RK3 relay locks and releases the GTL1 relay which releases the GTL2 relay.

Release of the GTL1 and GTL2 relays removes all of the ground which had been applied or extended by the DTM to the register by operation of GTL3 and GTU relays (SCD-B4-3.1-B4-3.5). Memory relays in the OR should, by this time, have operated and locked to off-normal ground provided by the ON relay of the OR. Each lead which had been grounded by the DTM to the OR should now have locking ground feeding back from the OR to the DTM so that check relays associated with these leads in the DTM remain operated. If the OR fails to return locking ground, indicating that the associated memory relay did not lock up, the associated check relay in the DTM will release causing the RK1 and RK2 relays to release.

B4-4 HOLD MAGNET OPERATION - NETWORK AND LINE TESTS

The sequence of hold magnet operation differs, depending on whether the marker determines that traffic is heavy or light (see sequence chart SFD-B003 and B005). Under heavy traffic conditions all hold magnets are operated at the same time with a minimum of checks and tests to reduce marker holding time. Under light traffic conditions, operation of the line hold magnet is delayed to permit a test of the talking path for crosses. After the line hold magnet has operated, a continuity test of the talking path crosspoints is made.

Headings of the following paragraphs are designated HTR, LTR, or HTR/LTR as an indication that the paragraph applies only to heavy traffic, only to light traffic, or to either heavy or light traffic operation.

B4-4.1 DETERMINATION OF LIGHT OR HEAVY TRAFFIC BY DTM - HTR/LTR (SFD-B410, B411)

Hold magnet operation as well as other marker functions differs according to whether traffic is light or heavy. The DTM determines whether the traffic is light or heavy by measuring the time between seizures of the DTM using the HTT timer (SFD-B111).

At the beginning of a call, the MCB- relays of the DTM are operated over the MB lead from the LLMC (SFD-B110). The MCB0 relay operated extends

ground on the TM lead to operate the OAT relay. If the HTR relay is already operated from the last call, it remains locked to ground through normal contacts of the HTT relay (SFD-B111). At the end of the call, the OAT relay releases. If the HTR relay is not already operated, it operates and locks releasing the OAT1 relay. With the OAT and OAT1 relays normal and the HTR relay operated, the shunt around the HTT capacitor (SFD-B111) is opened allowing the HTT capacitor to charge until the HTT tube fires and operates the HTT relay or until the DTM is seized again and the OAT relay operates to stop the timing. If the time between calls is greater than 0.96 to 1.6 seconds, the HTT relay operates releasing the HTR relay so that the next call is handled on a light traffic basis. If the interval is shorter than 0.96 to 1.6 seconds, the HTR relay remains operated and the call is handled on a heavy traffic basis.

B4-4.2 HOLD MAGNET TIMING - HTR/LTR

As described in preceding paragraphs, select magnets are operated on line link and trunk link frames upon operation of a CH- relay. (Refer to sequence chart SFD-B005.) Operation of a CH- relay also operates the CHA relay which starts a hold magnet timing interval. This time interval is necessary to allow select magnets to operate, for select fingers to seat, and for any previously operated hold magnets connected to this channel to release before operating hold magnets for this call.

Prior to operation of the CHA relay, current flows through the primary winding of the HMT relay in a direction to operate it while current through the secondary flows in a direction to release it. The combination of external resistance, winding resistance, and difference in number of turns is such that the current in the secondary prevents the HMT relay from operating. When the CHA relay operates, current in the secondary decreases as the HMT capacitor charges. When the effect of the current in the secondary becomes less than that of the current in the primary, the HMT relay operates. This operate time can be set at 26-30 ms by cross-connecting terminal HMS to HMT or to 40.5-50 ms by cross-connecting terminal HMF to HMT. The longer time interval is required in offices which have some switches which are not equipped with damping cones. Select fingers on these switches take longer to settle down.

Operation of the HMT relay operates the HMT1 relay.

B4-4.3 CHECK OF CHANNEL - HTR/LTR

Early in the call, the SLRK relay operates (SFD-B421) from ground on the LLC1 relay through normal contacts of the following relays to ensure that they are initially normal. SLA, LGCK, TGCK, JGCK, HMT1, LXPA, JXPA, LLTA, and if dual voltage operation is provided, DTK. If dual

voltage operation is provided, the SLRK relay subsequently locks when the TK relay operates. If the SLRK relay fails to operate, operation of a CH- relay (SFD-B415) is prevented.

In the process of channel test (SCD-B4-1.15, SFD-B412) busy channels are detected by looking for ground on sleeve leads. If ground is not detected on any of the three parts of a channel, it is presumed to be idle and one of the "idle" channels is selected by operation of a CH- relay (SFD-B415).

A further check of the channel is made after a CH- relay has operated. LGCK, JGCK, and TGCK relays (SFD-B423) are connected to line, junctor, and trunk hold magnet leads, respectively. These are high resistance sensitive relays which operate to battery on hold magnet windings without operating the hold magnets. This provides a positive check that the hold magnets associated with the three parts of the channel are idle (ungrounded). A further check of the sleeve of the line link selected is made by the LLT relay. If the line link is idle (ungrounded), the LLT relay will not operate.

B4-4.4 CROSS CHECK OF TRUNK SLEEVE - HTR/LTR

Prior to operation of the HMS1 relay, the XSL relay is connected to the AST lead (SFD-B423) to detect any cross to ground. If the XSL relay operates, it locks and operates the MXT relay which causes a trouble record showing an XSL punch.

B4-4.5 HOLD MAGNET START (SFD-B421) - HTR/LTR

If the following conditions are satisfied, upon operation of the HMT1 relay, the HMS1 relay is operated (SFD-B421).

- (a) The RK3 relay (SFD-B428) has operated, indicating a satisfactory check of transmitting relays.
- (b) The LGCK, JGCK, and TGCK relays (SFD-B423) have operated indicating that the hold magnets associated with the channel are idle.
- (c) The LLTA relay, which operates from the LLT relay (SFD-B414), is normal, indicating an idle condition (no ground) on the selected line link sleeve.
- (d) A number of relays to be operated later for various checks are now normal.

Operation of the HMS1 relay starts the operation of the hold magnets for the channel selected.

B4-4.6 HOLD MAGNET OPERATION HTR/LTR

Over the years a number of changes in method of hold magnet operation have been made. Only the standard dual voltage operation (as shown on SFD-B423) is described here. SFD-B424 shows a simplified drawing of the various options provided in the DTM for hold magnet operation but only those shown on SFD-B423 will be discussed in the SCD.

B4-4.7 DUAL VOLTAGE OPERATION - HTR/LTR

With the standard dual voltage option, all hold magnets except the line hold magnet are operated by a high voltage surge on all calls. The line hold magnet is operated by the high voltage surge except on calls to message rate lines in offices having message registers. This is to avoid the possibility of falsely operating the message register. Determinations of whether or not the line has a message register is made by cross-connections from class of service to relays such as 2P, 2PMR, MAN, CN, MCN, AO, or AOMR (SFD-B429). Of the relays illustrated, all but 2PMR (two party message rate) and AOMR (all other message rate) operate the DVO relay (SFD-B420), and the DVO relay operates the DVA relay. With the DVO and DVA relays operated, a high voltage surge is sent to operate the line hold magnet as described in SCD-B4-4.8.

B4-4.8 OPERATION OF LINE HOLD MAGNETS - HTR (SFD-B423)

Assume a heavy traffic call with a nonmessage rate line. Upon operation of the HMS1 relay, with the HTR, DVO, and DVA relays operated, ground is furnished through the primary winding of the LXP relay in series with the LH capacitor. The LH capacitor (which has previously been charged to +130 volts and acts momentarily like a 130-volt battery) is applied to the winding of the line hold magnet which is connected to -48 volt battery. The effect is as though a battery of 178 volts were connected to the relay winding. The voltage of the LH capacitor rapidly decreases to 0 and then to a fraction of a volt negative at which point the LH diode begins to conduct, so that the hold magnet is held operated to ground potential. Application of high voltage in this manner causes the hold magnet to operate in about 1/3 the time it would take it if 48, rather than 178-volt operation were used.

If the DVO and DVA relays are normal, 48-volt operation is used. That is, the ground through the winding of the LXP relay is applied directly to the hold magnet without the LH capacitor in series.

With or without surge voltage operation, the LXP relay operates in series with the line hold magnet. The LXP relay operates the LXPA relay which locks (SFD-B420).

B4-4.9 CROSSED LINE HOLD MAGNET TEST - LTR

The crossed line hold magnet test is made on light traffic calls only. It is unlike any other cross test in the DTM. It is made using a combination of the LHT relay and the XLH relay. The LHT relay (SFD-B420) operates early in the call and locks around the normal contacts of the FTK1 and XLH relays. It would appear that there would be an XLH punch, if a trouble record were taken any time that the LHT relay is operated. However, operation of the TRST relay releases the LHT relay at the start of a trouble record unless the XLH relay is operated.

With the LHT and CKG relay operated, ground and -48 volts through resistors are fed to one side of the XLH relay secondary winding and ground to the other. This biases the XLH relay in its nonoperated position.

On light traffic calls (HTR relay normal), operation of the HMS1 relay connects the primary winding of the XLH relay to the line hold magnet (LH) lead (SFD-B423). The XLH capacitor is in series with the primary winding so that only a surge of current can flow. The secondary of the XLH relay (SFD-B420) is biased in such a manner that the surge of current through one line hold magnet is not sufficient to operate it. But, if the hold magnet is crossed to a second line hold magnet, the XLH relay will operate. Operation of the XLH relay removes ground from the negative side of the XLH relay secondary winding (the FTK1 relay would be operated at this time) and allows -48 volt battery through the XLH3 resistor to bias the XLH relay in its operate position. The XLH relay also locks the LHT relay so that would not be released by subsequent operation of the TRST or GLH relays. Late in the call, after the DCT1 relay operates and the DCT relay releases, if the LHT relay is operated, the TRR relay operates (SFD-B502) to force a trouble record with a regular release. An XLH condition does not prevent the call from being set up.

B4-4.10 OPERATION OF JUNCTOR AND TRUNK HOLD MAGNETS - HTR/LTR

The HMS1 relay (SFD-B423) closes ground through the JXP relay primary winding in series with the JH capacitor charged to +130 volts over the J- lead to the winding of the J- line junctor hold magnet.

The HMS1 relay also closes ground through the TXP, TXP1 ballast lamps in series with the TH1,2, and 3 capacitors charged to +130 volts over the LH- lead to the trunk and trunk junctor hold magnets. As described for high voltage surge operation of line hold magnets, the magnets operate in about 1/3 of the time required for -48 volt operation. When the capacitor discharges, the magnets continue to be held operated through the diodes to ground through the JXP relay or the TXP, TXP1 ballast lamp. The JXP relay operates in series with the line junctor hold magnet and operates the JXPA relay which locks.

B4-4.11 CROSSPOINT CHECK (SFD-B421,B423) - HTR/LTR

B4-4.11.1 Heavy Traffic

When the hold magnet have operated, the low resistance ground from the TXP, TXP1 ballast lamps operates the SL relay and releases the LXP and JXP relays (SFD-B423) which operate the LXP1 and JXP1 relays, respectively (SFD-B420). The SL relay operates the SLA relay. The LLT relay, which has previously operated when operation of the line junctor hold magnet grounded the line link sleeve (SFD-B414), operates the LLTA relay. Operation of the SLA, LLTA, LXP1 and JXP1 relays closes ground through previously operated HTR relay to operate the GT1 relay which locks (SFD-B421).

B4-4.11.2 Light Traffic

Crosspoint check on light traffic is the same as preceding, except:

- (a) Line hold magnet operation does not occur at the same time as operation of the other hold magnets when the HTR relay is not operated (SFD-B423).
- (b) Operation of the SLA, LLTA, and JXP1 relays closes ground through the normal HTR, LXPA, and LXP1 relays contacts and previously operated LHT and RK3 contacts to operate the LTR (light traffic) relay (SFD-B421) instead of the GT1 relay.

B4-4.12 FALSE CROSS AND GROUND TEST (SFD-B423) - LTR

On light traffic calls, a test for crosses of the network tip and ring conductors is made. For this reason, the operation of the line hold magnet operation is delayed during the test so that crosses or grounds external to the network are not detected.

Ground through the secondary and battery through the primary windings of the FCG relay are connected to the ATT and the ART leads, respectively (SFD-B425), if the RCTA relay is normal or to the ART and the ATT leads, respectively, if the RCTA relay is operated. The RCTA relay operates only on light traffic calls having the JLO relay normal. The JLO is alternately operated and normal on successive calls (see sequence chart SFD-B404).

The FCG relay will operate, if:

- (a) The network T or R lead connected to the secondary winding is crossed to a lead having a voltage negative to ground.
- (b) The network T or R lead connected to the primary winding is crossed to a lead having ground or a voltage between -48 volts and ground.

- (c) The network T and R leads are crossed to each other. This meets both conditions (a) and (b).

When the LTR relay operates (SFD-B421) indicating that all crosspoints other than those for the line hold magnet have closed, a locking ground is provided for the FCG relay in case it has operated (SFD-B425). If the FCG relay has not operated, the GLH relay operates (SFD-B421).

The GLH relay disconnects the FCG relay from the ATT and ART leads and grounds both leads to discharge any voltage remaining on them from the FCG test.

B4-4.13 DELAYED OPERATION OF LINE HOLD MAGNET - LTR

The GLH relay operates the GLH1 relay (SFD-B421). With both the GLH and GLH1 relays operated, the line hold magnet is connected either directly in series with the LXP primary winding to ground if the DVO and DVA relays are normal or in series with the charged LH capacitor to ground through the LXP primary winding if the DVO and DVA relays are normal (SFD-B423). The LXP relay operates and operates the LXPA relay (SFD-B420). When the line crosspoints close, the LXP relay is caused to release by ground from the TXP and TXP1 ballast lamps. This operates the LXP1 relay.

B4-4.14 CONTINUITY TEST - GENERAL - LTR (SFD-B425)

A continuity test of the talking path through the network is made on light traffic calls. In order to check continuity of the path through the network, a path from tip to ring conductors or from either tip or ring to ground external to the network is required (SFD-B425). Twenty-hertz ringing supply is stepped up to a higher voltage by the CON transformer. With the GLH1 relay normal, the output of the CON transformer is open-circuited. There is no current flowing and, therefore, no voltage built up across the CON2 capacitor. When GLH1 relay operates, (assume RCTA relay normal) the CON transformer is connected through the network to the ring side of the line. Ground is connected to the tip side. On nearly all calls, the off-hook status will be connected across the tip and ring so that there will be a relatively low dc resistance in the loop. Current will flow, causing an alternating voltage to appear across the CON2 capacitor. Terminal 1 of the CON tube is connected through the CON1 resistor to the CON2 capacitor. If the voltage at terminal 1 reaches the firing voltage of the CON tube, even momentarily, the CON tube fires and continues to conduct between terminals 2 and 4 to operate the CON relay even though the voltage at terminal 1 is no longer above the firing voltage.

Occasionally the station will go on-hook just before the continuity test is applied. If this is an individual line, the path through the ringer and the series capacitor allows sufficient 20-Hz current to flow to

raise the voltage across the CON2 capacitor to the firing voltage. The same holds true for a ring party line. In this case current flows through the network ring lead only, through the ringer and capacity to ground and back through the earth to the central office ground. If there is only a tip party connected to the line, insufficient current may flow and the CON tube may not fire at this time (still assuming that the RCTA relay is normal at the beginning of the continuity test). As described in more detail later, the RCTA relay operates after a short interval to reverse the continuity test. Now current flows through the tip lead through the tip party bell and capacitor back through the earth to the central office ground. If the RCTA relay had been initially operated and only a ring party station had been connected, the RCTA relay would have released to apply the continuity test to the ring side of the line.

On long lines, the cable capacity is sufficient to satisfy the continuity test even if there is no other path through ringers or transmitter.

B4-4.14.1 Continuity Test Reversal Control - LTR

When the ONX relay (SFD-B425) operates from the CKG2 relay early in the call, the RCTB relay is operated. After the LCK relay operates, the RCTA relay operates providing the JLO relay is normal. The RCTA relay normal applies the continuity test to the tip path. Since the JLO is alternately operated or normal on successive calls (SFD-B404, B405), the RCTA relay is alternately normal or operated on successive calls.

Upon operation of the LXP1 relay (which signifies that the line hold magnet has operated), the operate path for the RCTB relay is opened. The RCTB resistance connected across the winding of the RCTB relay slows the release of the RCTB relay to allow time for the continuity test to be completed if there is continuity, in which case the CON1 relay will operate, which as explained in the next section prevents release of the RCTB relay. If the RCTB relay does release, the RCTA relay, if normal, will be operated, or, if operated, will be released so that a second test in the reverse direction to the first is made.

B4-4.14.2 Continuity Test Description - LTR

Operation of the GLH1 relay, in addition to starting operation of the line hold magnet, also starts the continuity test. Stepped up 20-Hz ringing supply voltage through the CON transformer in series with the CON2 capacitor to ground is applied to either the tip or to the ring of the path through the network depending on whether the RCTA relay is operated or normal. Ground is applied to the other side of the path through the network. The GLH1 relay also applied +130 to a voltage divider supplying the winding of the CON relay.

If there is a continuity through the crosspoints and continuity external to the network, the voltage across the CON2 capacitor builds up sufficiently to fire the CON tube. The CON relay operates, in turn operating the CON1 relay which locks. The CON1 relay closes a locking path to prevent release of the RCTB relay (if it has not already released), operates the GT1 relay which locks (SFD-B421), and grounds the control terminal 1 of the CON tube. The GT1 relay removes positive battery from the CON relay allowing it to release. This, combined with the grounding of control terminal 1, extinguishes the CON tube.

The CON1 and CON3 capacitors are small and serve to prevent false firing of the CON tube from electrical noise pulses.

B4-4.14.3 Continuity Failure Trouble Record - LTR

As previously mentioned, if the CON tube fails to fire before the RCTB relay releases, the RCTA is operated if normal or released if operated and a test on the other side of the line is made. If the CON tube again fails to fire, the CON and CON1 relays do not operate and the DTM can not proceed with the call. The work timer which is recycled upon operation of the LXP1 relay (SFD-B005, B111) times out after 245 to 456 milliseconds causing a trouble record showing WT and LTR punches and progress through the DCT punch but not including the CON punch.

B4-4.14.4 Cancel Continuity (SFD-B423) - LTR

On second trial calls, the operation of the GLH1 relay operates the CON1 relay from ground on the operated TR2B thus automatically cancelling the continuity test. On heavy traffic calls, operation of the LXP1 relay with the HTR relay operated operates the GT1 thus cancelling continuity test by bypassing operation of both the CON and CON1 relays.

Continuity test can be cancelled on all calls for all markers by operating the CCT key at the master test frame jack lamp and key panel.

B4-4.14.5 Multiple of Ringing Supply Between Markers and Detection of Loss of Ringing Supply

The multiple arrangement of the ringing supply to all markers is shown on SFD-C427 (for offices having 12 or less markers). Connected to the last marker of the multiple is a detection circuit consisting of a bridge rectifier across the ringing current leads and a relay ACV across the output of the bridge which remains operated as long as there is ringing current voltage. The ACV relay holds the ACV1 relay operated, if there is a loss of ringing voltage. The ACV relay holds the ACV1 relay operated. If there is a loss of ringing voltage for any reason the ACV and ACV1 relays release, in turn lighting the ACV lamp, bringing in a minor alarm and operating the CCT relay which cancels the continuity test in all markers. If the continuity test were not cancelled upon loss of ringing current, markers would time out on light traffic calls.

B4-4.15 DOUBLE CONNECTION CHECK - LTR/HTR

On both light and heavy traffic calls a double connection check is made to ensure that the sleeve of the connection being set up is not crossed with the sleeve of another connection already set up or in the process of being set up. Although operation of the line hold magnet is slightly delayed on light traffic calls, the double connection test is made in the same manner on both light and heavy traffic calls.

When the LXP1, JXP1, and SLA relays have all operated, as previously described, the LXP and JXP relays and the TXP, TXP1 ballast lamps are disconnected from respective leads to line and trunk link frames. At the same time the DCT relay is connected to the LH- lead to the line link frame. The DCT relay winding now provides the only ground from the DTM to keep the hold magnets operated. Bias current through the secondary winding of the DCT relay is such that the DCT relay will operate if there is no other ground feeding the connection such as would occur if the sleeve path were crossed to an established network connection.

B4-4.15.1 Heavy Traffic

On a heavy traffic call the GT1 relay operates upon completion of the cross-point check (SCD-B4-4.11). With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

B4-4.15.2 Light Traffic

On a light traffic call, the GT1 relay does not operate until the CON1 relay has operated as a result of a successful or cancelled continuity test. With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

B4-4.16 HOLD MAGNET SIMULATION AND CONTROL BY MASTER TEST CONTROL ON DT CLASS OF TEST (SFD-B422, B423)

On a DT class of marker test, it is desirable to be able to test the marker using any line location information. To avoid the possibility of having a customers line become locked into the test call if the line should happen to go off-hook during the progress of setting up the test connection, line hold magnet operation is simulated.

B4-4.16.1 NTC Key Normal

The MT11 relay of the DTM is operated on test calls. This opens the path over the LH- lead (SFD-B423) to the line link frame which would normally be used to operate the line hold magnet on a service call. Instead, on a test call the path is extended over the LHMT lead to the MTC and through the MKT2 relay to the LHM relay (NTC key and NTC1 relay normal) (SFD-B422). The LHM relay and the LHM resistance are chosen to present an impedance to the marker equivalent to that of a line hold magnet.

When the HMS1 relay of the marker operates, the marker applies either the high voltage surge for dual voltage or ground through the winding of the LXP relay to operate the LHM relay of the MTC. The LHM relay operates the LHMA relay which extends the LHMT lead to the LLJ lead. The LLJ lead ties into the J lead of the DTM to the trunk link frame at a point ahead of the CH- relay to simulate the path which would have been closed on a service call over the LH- relay lead to the LL, through the junctor and back over the J- lead to the DTM. This permits the marker to go through all the motions of crosspoint and double connection checks. It will actually close junctor crosspoints on the LL, but checks are made through the simulated path just described. The DTM operates and checks crosspoints on the TL in the normal manner.

Upon completion of the DT class of marker test, when supervision has been turned over to the OR, the OR releases because the MTC does not provide a loop closure on the tip and ring path. When the OR removes ground from the sleeve lead, the whole connection releases. The LHM relay of the MTC releases slightly earlier as the marker and various connector relays release to open the paths used for line hold magnet simulation.

B4-4.16.2 NTC Key Operated

The NTC key of the MTC is operated on a DT class of test where it is desired to establish a connection and check the tip, ring, and sleeve path through the line link frame using all crosspoints which would be used on a service call except the line hold magnet crosspoints. Use is made of the no test connector* access to line link frames.

Operation of the NTC key on a DT class of test operates the NTC and NTC1 relays. The NTC relay operated closes battery over the SP lead to the MTFC to bid for the no test connector.

When the MTC gains access to the no test connector, the F1 relay of the MTC is operated. Operation of the F1 relay operates the NTC select magnets (associated with no test connector level assigned to the MTC) on all no test connector switches (see SFD-B431 as well as SFD-B423). The F1 relay also connects the NTB relay of the MTC via the NTH lead. The NTH lead is steered through the DTM and the HGA- relay of the LL to the winding of the NTC hold magnet of the no test connector associated with the line to be simulated. If the NTC hold magnet is in use, ground on

* The no test connector (SFD-B431) will be covered more completely in a subsequent section of the SFD and SCD. Its primary function is to provide access by operators and the local test desk to lines which are connected to a path through the network. The MTC makes use of the no test connector on test calls to provide a simulated line access to any horizontal of any line link frame.

its winding will be fed back to operate the NTB relay of the MTC which locks on its secondary winding and light an NTB lamp to indicate NO TEST BUSY. If this occurs, simulated hold magnet operation by the no test connector is blocked. The DTM work timer times out and a trouble card showing LXPA but no LXP1 would be produced.

If the NTC hold magnet is not in use, the NTB relay does not operate. Later in the call, when the DTM grounds the LHMT lead (which on a regular call would operate the line hold magnet), the NTH relay of the MTC is operated. The NTH relay extends ground from the NTB relay normal to the NTH lead to operate the NTC hold magnet of the no test connector.

The NTH relay also grounds the H lead to the no test connector to provide a holding path for the NTC hold magnet after the MTFC and DTM release. The NTH relay also bridges the LHMT lead to the S lead of the no test connector. The NTH relay, the NTC hold magnet of the no test connector, and the NT hold magnet of the line link frame combine to simulate a line hold magnet. The NTH relay simulates the winding. The NTC and NT hold magnets provide the crosspoint closure for tip, ring, and sleeve.

Upon completion of the DT class of marker test, when supervision has been turned over to the OR, the OR releases because the MTC does not provide a loop closure on the tip and ring path. When the OR removes ground from the sleeve lead, the whole connection releases. The NTH relay of the MTC, which at this point is locked to the sleeve, also releases and releases the NTC hold magnet of the no test connector and the NT hold magnet on the line link frame.

B4-4.16.3 Dual Voltage Test on DT Class of Test

When dual voltage operation is provided, the LHMT, LLJ, and TLH relays of the master test control are connected to the LHMT, LLJ, and TLH leads, respectively. If the DTM applies the high positive voltage surge to each of these leads, the corresponding relays should operate to light the LHMT, LLJ, and TLH lamps, respectively. Current through the lamps also locks the relays. Tests should be made using message register class of service, if provided, to ensure that the high voltage surge is not applied and therefore that the LHMT lamp does not light for these classes. The LHMT lamp should light for all other classes. The LLJ and TLH lamps should light for all classes.

B4-4.17 HOLD MAGNET CONTROL BY THE MASTER TEST CONTROL ON OR CLASS OF TEST

On an originating register (OR) class of test, the master test control establishes a connection through the network to an originating register from either an originating test line or via the no test connector. When the originating test line is used, the only line location information

which can be put into the OR is that of the originating test line. By using the no test connector, any desired line location may be simulated and therefore may be transmitted to the OR.

B4-4.17.1 NTC Key Normal

The MT11 relay of the DTM is operated on test calls. This opens the path over the LH- lead (SFD-B423) to the line link frame which would normally be used to operate the line hold magnet on a service call. Instead, on an OR class of test, the path is extended over the LHMT lead to the MTC and through the SRT2 relay (NTC key and NTC1 relay normal) to the LHM lead. The marker therefore connects to the LH- lead as it would on a service call. When the NTC key is normal on an OR class of test, the line location of the originating test line is automatically transmitted to the DTM from the operated OTL2 relay (SFD-B107) so that the line hold magnet operated is that of the originating test line.

B4-4.17.2 NTC Key Operated

An OR class of test with the NTC key operated functions as described in SCD-4-4.16 for the DT class of test with the NTC key operated, except that the AMRST does provide a loop on the tip and ring so that the OR retains a ground on the sleeve to hold up the connection.

It should be noted (SFD-B107) that, with the NTC key and therefore the NTC1 relay operated, the KVG1,2 relays rather than the OTL2 relay are operated. This makes effective the line location keys or switches which permit any line location to be set up.

B4-4.18 TEST OF NETWORK TALKING PATH TROUBLE DETECTION FEATURES OF THE DIAL TONE MARKER

The dial tone marker makes tests of the tip and ring path through the network on light traffic calls. In making the tests described in the following paragraphs, the DTM should be made busy. It will then function on a light traffic basis if there is over about 1-1/2 seconds between the end of the one test call and the start of the next. The DTM can be forced to function on a heavy traffic basis if desired by operating the HTR key of the MTC (SFD-B111).

B4-4.18.1 Test of False Cross and Ground Detection Feature of the Dial Tone Marker (SFD-B425)

B4-4.18.1.1 FCG Key Normal

With the FCG key normal on DT class of test, the FCG relay of the DTM is connected to the network T and R leads prior to operation of the GLH and GLH1 relays. As on service calls, crosses or grounds on the T and R leads will be detected on light traffic calls.

B4-4.18.1.2 FCG Key Operated

With the FCG key operated on DT class of test, the FA resistor is bridged across the TTT and TRT leads to the marker. This applies a current which should operate the FCG relay causing a trouble card to be produced showing an FCG punch. If the HTR key is operated, the DTM should not detect the FCG condition.

B4-4.18.2 Test of Continuity Test Feature of the Dial Tone Marker (SFD-B425)

B4-4.18.2.1 CON and RV Keys Normal, TC Key Operated or Normal

With the CON, RV, and TC keys normal on a DT class of test, an operate condition originating at the voltage divider resistors CL, CM, and CK, through the CG and CF resistors is applied to the TRT lead. On alternate test calls the RCTA relay of the DTM is operated so that the initial continuity test is made on the RING (the TRT lead on a test call). The CON tube should fire and the call should be completed. On calls with the RCTA relay of the DTM normal, the initial continuity test is made on the TIP (the TTT lead on a test call). Since the TTT lead is open, the CON tube does not fire initially, but (as described for a service call) it should fire after release of the RCTA relay applies the continuity test to the TRT lead. Two consecutive calls should be made to ensure one test with RCTA initially normal and one test with RCTA initially operated. With the TC key normal, a negative bias is applied to the operate path of the CON tube. A test should also be made with the TC key operated to apply a positive bias to the CON tube operate path.

B4-4.18.2.2 RV Key Operated, CON Key Normal, TC Key Operated or Normal

Operation of the RV key with the CON and TC keys normal applies the above continuity operate test condition to the TTT lead instead of the TRT lead. Two consecutive tests should be made to ensure one test with RCTA initially operated and one test with RCTA initially normal. As described previously, the TC key may be operated or normal to apply positive or negative bias to the CON tube operate path.

B4-4.18.2.3 CON KEY OPERATED, RV AND TC KEYS NORMAL

With the CON key operated, a loop continuity operate condition is applied across the TRT and TTT leads. The CON tube should fire for OK continuity on its initial attempt whether the RCTA relay is operated or normal.

B4-4.18.2.4 TCT Key

The TCT key is not intended for use in testing dial tone markers.

SECTION B, PART 5
MARKER RELEASE AND DIALING

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B5 MARKER RELEASE AND DIALING

Upon completion of the double connection check on heavy traffic or upon completion of both the double connection check and the continuity test on light traffic (SCD-B4-4.15), the DCT1 relay operates. This starts the release of the marker and cuts dial tone through from the originating register to the calling line.

B5-1 MARKER RELEASE (SFD-B006,B502)

The operation of the DCT1 relay, which locks, releases the F relay of the OR (SFD-B209). Release of the F relay of the OR releases the FA-2 relay of the TL (SFD-B421). Release of the FA-2 relay releases the SL relay of the DTM (SFD-B423) and applies low resistance (10-ohm) ground through the S resistance of the OR to the sleeve lead of the connection which, up to this time, had been held up by ground through the primary winding of the DCT relay. The low resistance ground now provides so much of the current to hold up the connection that there is insufficient current through the DCT relay to hold it operated. Release of the DCT relay operates the DIS1,2 relays (SFD-B502). Operation of the DIS1,2 relays (which lock) starts the release of relays in the DTM (SFD-B006) and in various connectors and then the release of the DIS1,2 relays leaving the DTM normal and ready for the next call.

If the LLMC had given the DTM a TRS signal (indicating that there had been a transfer of start leads in the MTFC), the release of the DCT relay would operate the TRR relay. The TRR would operate the TRST relay which would operate the MPR- relay of the MTFC to request a trouble record showing a TRS punch. Upon completion of the trouble record, or if the trouble recorder were busy, the TRB relay of the DTM would be operated. This would operate the DIS1, 2 relays for a regular release of the marker.

If the DTM detects a cross connection, or if the work, short frame, or long frame timer times out, the MXT, WT, SDT or LDT relay is operated (SFD-B207, B111) and in turn operates the SP and TR1 relays. The SP relay opens a number of paths in the DTM to stop marker progress beyond the point of failure. The TR1 relay operates the TRST relay which operates the MPR- relay of the MTFC to request a trouble record. When the trouble record is complete or if the trouble recorder is busy, the TRB relay of the DTM is operated. This operates the TRL and TRLA relays causing the marker to give a trouble release (TRL) signal to the LL (SFD-B106) if the DTM is working on a first trial basis (TR2B normal) or to give a BT trouble release signal if the marker is working on a second trial basis (TR2B operated).

As previously described, the VGR, HGR, and FR relays monitor the request from the LL which resulted in selection of a particular VGT-, HGT-, or VFT- relay, if the subscriber hangs up during the time that the DTM is identifying the line. Release of the VGR, HGR, or FR after selection of a VGT-, HGT-, or VFT- relay operates the DIS1,2 relays causing the marker to release.

B5-1.1 CONTROL OF MARKER RELEASE BY THE MASTER TEST CONTROL ON TEST CALLS

B5-1.1.1 Rec Key Normal

On DT and OR classes of test, the MT1 and MT15 along with other test relays are operated in the DTM. When the DTM progresses to the point of operation of the DCT relay on a test call (SFD-B502), the DCT relay of the MTC is operated. If the REC key of the MTC is normal, the DCT relay of the MTC operates the MO1 relay. This closes ground from the DCT relay operated to operate the DCT1 relay over the TDCT lead. When the DCT relay releases, it operates the LK2 relay of the MTC which locks, lights the LK2 lamp, and extends ground over the LK3 lead to the DTM then back over the DIS1 lead to operate the DIS1 relay of the MTC. The DIS1 relay locks, lights the DIS1 lamp, and grounds the DIS lead to operate the DIS1,2 relays of the DTM allowing the DTM to release.

B5-1.1.2 Rec Key Operated to Request a Trouble Record

On DT and OR classes of test with the REC key operated, operation of the DCT relay of the DTM operates the DCT relay of the MTC (SFD-B502). The DCT relay of the MTC operates the REC relay which extends its operate ground to operate the TRR relay of the DTM. The TRR relay operates the TRST relay which operates the MPR- (marker preference) relay of the MTFC to request a trouble record.

Upon completion of the trouble record or if the trouble recorder is busy, the TRB relay of the DTM operates. The TRB relay operated closes ground through the TRR relay contacts to the MO1 lead via the MTFC and through the REC key and DCT relay operated to operate the MO1 relay. The operated MO1 relay closes ground to the TDCT lead to operate the DCT1 relay of the DTM. Upon release of the DCT relay, the test call progresses to release the marker as described previously.

B5-2 DIALING

All of the preceding description covers the actions taken by the DTM and connecting circuits to establish a dialing path through the network to the originating register. These actions normally take about one tenth of a second. The following description covers the actions taken to make

certain checks of the line, to give dial tone as a signal to start dialing, to receive the dialed digits, and to determine when a full number of digits has been dialed.

B5-2.1 DIAL TONE (SFD-B503,B504)

The S1 relay of the OR is operated early (SFD-B507) when the LV2 relay of the TL operates. The S1 relay operates the ON relay. If the call is for a 2-party line as indicated by class of service, the 2P relay is operated in the OR (SFD-B427). Other classes of service such as manual or coin cause the MAN or CN relay to operate.

B5-2.1.1 2-Party Line

If the 2P relay is operated, indicating a 2-party line, the TPD, TPA, and TPT relays operate (SFD-B503). Later when the F relay releases (SFD-B209), it releases the FA2 relay of the TL (SFD-B419) and starts release of the slow release TPD relay which allows time for a test of the tip and ring of the line. The release of the FA2 relay connects the TP relay to both the T and R leads to the line. This is done to determine whether the tip party or the ring party initiated the call. If the tip party is off-hook, there is resistance ground through the ringer to both sides of the line so that the TP relay will operate. The ring party has a capacitor in series with the ringer so that it does not ground the T and R leads. The TP relay may operate momentarily from capacity discharge but will release if only the ring party line is off-hook.

If the TP relay is operated when the TPD slow-release relay releases, it operates the TP1 relay as an indication that the tip party line was off-hook during the first party test. (A second party test made after completion of dialing will be described later.) Release of the TPD relay starts release of the slow-release TPT relay which releases the TPA relay. Release of the TPA relay connects the L relay winding to the ring of the line and ground to the tip. The L relay operates over the loop through the off-hook station. The L relay operates the SR relay which operates the ON1 relay (SFD-B511) to connect dial tone through the TN transformer to the line.

B5-2.1.2 Other Than 2-Party Lines

For other than 2-party lines (TP relay normal), the party test is omitted and dial tone is connected as shown on sequence chart SFD-B504. The release of the FA2 relay of the TL closes through the T and R to operate the L relay over the loop through the off-hook station and back to ground at the TN transformer. The L relay operates the SR relay and in turn the ON1 relay which closes dial tone through the TN transformer to the line.

B5-2.2 SUBSCRIBER DIALING

When the subscriber inserts a finger in a hole in the dial, pulls it to the stop and lets go, the dial opens and closes a contact the number of times corresponding to the digit associated with the hole except for the digit 0. For the digit 0, the dial generates ten pulses. When the dial contact is open, a pulse interval is generated. The time between pulses of a digit (dial contact closed) is referred to as an interpulse interval. The dial contact is also closed between digits. This is known as the interdigital interval. The interdigital interval under normal circumstances is appreciably longer than the interpulse interval. This difference permits the OR to determine the end of each string of pulses for each digit. If the customer forces the dial or slows it, or plays with the switchhook pulse, interpulse, or interdigital intervals may be generated, which are too long or too short so that the OR cannot recognize them properly. Similarly, lines which have excessive leakage or intermittent crosses may distort pulses or may generate false pulses. Any of these conditions outside of the central office may result in misdirection of calls and may or may not produce trouble record cards.

B5-2.3 PULSING RELAY

The L relay of the OR (SFD-B503) is a magnetically biased polarized mercury contact relay with three windings. The primary is used as a line winding and is used to operate the relay in a circuit which includes the customer loop. The tertiary is used as a pulse aiding winding and is wired in series with the pulse help capacitor PH to a make-contact of the L relay. This contact also is wired to the winding of the slow-release supervisory (SR) relay. When the L relay operates and closes ground to the PH capacitor, it charges through the tertiary winding and the current is in a direction to hold the L relay operated. This current is reduced to zero as the capacitor becomes charged and the other windings exercise full control.

When the circuit to the primary winding is opened, the L relay releases to open ground from the PH capacitor which then discharges through the winding of the SR relay. The current in the L tertiary winding is in a direction to hold the L relay released. The tertiary winding and the PH capacitor thus act to ensure that once the L relay operates, it will remain operated for a definite minimum interval. This pulse correcting action makes possible longer maximum loops and higher capacity ringing bridges than would otherwise be possible. The tertiary winding is also used to hold the L relay through the marker connector when the completing marker is engaged and is also used for slight weakening the L relay when operating with ground start coin lines. When the coin (CN) relay operates, it closes a circuit to energize the tertiary winding in a direction to aid the primary winding. This is necessary to prevent "showering," a condition which exists when the line circuit relay operates on a

loop which will not hold the register L relay. If a leak condition exists on the line, which will cause operation of the line circuit relay, the dial tone marker will be called to connect the line to a register. Then if the register relay does not operate, the register will release and reconnect the line to the line circuit relay to start the marker action again. To prevent this showering the register, the L relay is biased to hold on any line which will operate the line circuit relay.

The secondary winding is used for slightly altering the sensitivity of the L as it operates and releases. This winding is also connected to the make-contact of L and is so poled that its ampere turns oppose those of the primary winding when L is operated. This has the effect of making L, once it operates, slightly stiffer or easier to release and once it releases, slightly weaker or easier to operate. The value of the LA resistor is chosen to give the optimum benefit from this winding.

The contacts of the L relay consist of a common armature spring No. 3 making contact with two independent front contacts numbered 1 and 2, and two independent back contacts numbered 4 and 5.

The LW capacitor and resistor network connected to the line side of the primary winding of the L relay is for preventing a premature release of the L relay when working with customer lines which have high-capacity ringing bridges. On each open pulse on these lines the line current momentarily dips and then increases as the bridged capacitor charges in series with the inductive ringer. The LW capacitor holds the L relay over the dip in the line current. This network is also used to prevent a false momentary release of L when an inductor holding bridge is inserted into the loop after the dialing of each digit at a PBX.

The winding of the supervisory relay SR is connected to the No. 1 front contact of the L relay and is energized whenever L is operated. This relay is slow-release and will hold over the momentary opens of the L front contact which occurs during the dialing of a digit. It will release, however, to cause release of the register if the customer abandons the call.

B5-2.4 SUPERVISORY CONTROL

The winding of the RA relay (SFD-B507) is connected through an ON1 relay contact to a break contact of L and is energized whenever the L is released with ON1 operated. This relay is made slow-release by the action of its secondary winding which is short-circuited whenever the relay is operated. This secondary is a precision winding with a resistance tolerance of only ± 3 percent so that the variation in release time of the relay is held within reasonably close limits. Since this winding is open during the operation of the relay, the relay is reasonably fast in operating. Relay RA will operate during the first dial

open pulse when L releases and will remain operated until the inter-digital interval when L is held operated for longer than the release time of the RA relay.

The auxiliary register advance (RA1) relay is controlled from a back contact on RA and works in reverse to RA, operating when RA releases and releasing when RA operates. The RA1 is a fast-operate and fast-release relay.

B5-2.5 DIAL PULSE COUNTER (SFD-B507)

Two methods of showing relay operation of the pulse counter are presented. SFD-B504 uses the conventional sequence chart; SFD-B506 uses a different chart arrangement which shows time relation between the L relay, counting relays and register leads. The upper position of the line associated with each relay or lead designation indicates relay operated or lead grounded. The lower position of each line indicates relay released or lead ungrounded. Shaded portions indicate time during which the magnetic flux of the RA relay reduces to a point where the relay releases. Register leads are grounded between the release of the RA relay and the operate of the RA1 relay. One or both of these charts should be followed while reading the following paragraphs.

The dial pulse counting circuit consists of relays P1 to P5 and P2A. Relays P1 and P2 are used in a pulse-dividing capacity with each relay functioning from the L relay but at half the speed. These relays are controlled by a break and a make contact of L. When L releases on the first dial open with SR operated, P1 is operated through the back of a continuity contact on P2. Relay P1 locks through this continuity contact on P2, through its own make-contact to ON ground. When L reoperates at the end of the first open pulse, ground through L make contact and through contacts of P1 operated, operates P2. Relay P2 locks to the ON ground through P1 operated and opens its operating circuit on a continuity contact, transferring the holding circuit for P1 from the ON ground to the ground at the break contact. On the next release of L, P1 releases. The P1 in releasing opens the holding circuit to the ON ground for P2, but P2 is held to the ground at the break contact of the L relay. The locking circuit of P2 to a contact of P1 will hold P2 over any stagger that may occur between the opening of the L break contact. On the next operation of L, P2 releases. This cycle is then repeated with P1 and P2 remaining operated at the end of each odd-numbered pulse and remaining normal at the end of each even-numbered pulse. Relays P3, P4, and P5 are used in various combinations to count and remember the number of operations of P1 and P2. Relay P3 and P2A operate when P1 releases at the start of the second open pulse. Relay P2A locks to ground from the ON relay for the rest of the call. P4 operates when P2 operates at the end of the third open pulse; and P5 operates when P2 releases at the end of the sixth open pulse.

B5-2.6 PREFIX COUNTER (SFD-B507)

Either a single 1-pulse or two 1-pulse digits may be dialed before the other digits as an indication that some special action is to be taken. Where it is required that the register recognize these prefix digits, the prefix counter, consisting of the relays 11A, 11B, and 11C, is provided (SFD-B507).

The detailed operation of the prefix counter is as follows. When RA releases after the first 1-pulse digit is counted, a circuit is closed for operating 11A. Relay 11A locks and closes a circuit for operating 11B when P1 releases as a result of the operation of RA1. If a second 1-pulse digit is counted, 11C operates through front contacts of 11B after RA releases at the end of the digit. Additional 1s will have no effect until after a digit greater than 1 has been dialed to cause the P2A relay to operate and lock. The P2A relay (when normal) opens the 0 and 1 output leads toward the digit register and steers the 1 lead toward the prefix 1 counter. Operation of the P2A relay opens the 1 lead toward the prefix 1 counter and closes the 0 and 1 leads toward the digit register.

B5-2.7 PULSE COUNTER OUTPUT (SFD-B507)

At the end of a string of pulses representing a digit, the longer inter-digital time allows the RA relay to release operating the RA1 relay. The release of the RA relay (SFD-B507) closes ground through the P-relays to the leads 0, 1, 2, 4, and 7 through steering relay contacts to digit register relays (SFD-B508). Operation of the RA1 relay opens these leads. Since the release of the RA relay starts operation of the RA1 relay, the leads to the digit register are closed only during the operate time of the RA1 relay. This is an adequate time since the digit register reed relays are very fast operate. Refer to chart on SFD-B506.

B5-2.8 DIGIT STEERING

The digit steering relays, AS-STS (SFD-B508), serve to connect to the digit register successively as the digits are received. The steering circuit is also used in conjunction with other circuitry to indicate when dialing is completed. This circuit consists of one relay per digit and its advance is under the control of the RA1 relay.

The A digit steering relay AS is operated when ON operates at the start of the call. Relay AS locks through a back contact on BS. When RA1 operates at the end of the first digit with P2A operated, BS operates through a front contact of AS. The BS locks through a back contact of CS and opens its operating circuit on a continuity transfer contact to the RA1 contact, so that when RA1 releases at the start of the next digit AS releases. This action repeats for each digit with the steering relay for the next digit operating when RA1 operates at the end of a

digit and the steering relay for the digit just registered releasing when RAL releases at the start of the next digit. The five output leads of the pulse counter are carried through individual transfer contacts on the steering relays and are closed to the digit register associated with the lowest lettered operated relay. For example, with both AS and BS operated, the leads are associated with the A digit register. The transfer from one digit register to the next takes place on the release of the lower-lettered relay.

B5-2.9 DIGIT REGISTER

The digit register unit for each digit consists of a dry reed relay, with five independent coils enclosed in a can with each coil associated with two make-contacts. One side of each of the coils is wired internally to one of its associated contacts for locking purposes and a single lead wired to a terminal. One contact of the locking contact pair, one side of the coil, and both contacts of the load contact pair are wired to individual terminals. These terminals extend to both the front and rear of each relay. For ease of wiring, three sets of terminals are strapped internally. These are the battery side of the coils, the locking contact of the relay, and one side of the load contact. Eleven or twelve of these digit register units are provided.

B5-2.9.1 Tool for Reading Digit Registers

It is possible to determine what digit is recorded in a digit register unit by attaching a KS-16751 tool to the front of the unit. The tool contains five lamps designated 0, 1, 2, 4, and 7. Lamps will light corresponding to operated relays within the unit.

B5-2.10 OPERATOR CALLS

When a 0 is dialed as the first digit*, the counter counts 10 pulses and operates the MAN relay (SFD-B507). The A4, A7 relays are also operated in the A digit register. If the calling line has manual class of service, the MAN relay is operated by the DTM (SFD-B429). In either event, operation of the MAN relay causes the OR to connect to a completing marker. If the CN relay is operated, the OR makes a test for coin ground before connecting to the CM. If the 2P relay is operated, the OR makes a second party test before connecting to the CM.

* There are other optional arrangements such as (0+ calls) where a 0 can be dialed in the first digit followed by the full number for person-to-person and other special calls. These options are not covered in this SFD.

B5-2.11 DIGITS HAVING MORE THAN 10 PULSES

Although dials are arranged to generate a maximum of 10 pulses for a digit, there are times when more than 10 pulses may be received by the L relay of the OR. This may occur as a result of misuse of the dial, jiggling the switchhook or by hits on the line which produce extra pulses. Faulty adjustment of the L or RA relays of the OR might also cause a count of over 10.

At the beginning of an eleventh pulse, operation of the P1 relay opens the locking path of the P3 relay to release it. With the P5 relay operated and the P4 relay normal, there is no path for reoperation of the P3 relay by additional pulses. This opens all but the 0 lead from the output of the counter for any number of pulses greater than 10.

B5-2.12 SUMMARY OF DIAL PULSE COUNTING AND REGISTRATION

The counting and registration of a digit takes place as follows. The L relay responds to the customer dial and the counting circuit counts the number of pulses. After the last pulse of the digit, L remains operated and RA releases. Relay RA closes an ON ground, connected through an MST1 break-contact, through two separate break-contacts to the translating contact of the counting relays. This ground emerges through separate break-contacts of RA1 on two of the output leads 0, 1, 2, 4, and 7 and is connected by the steering relay to a digit register to cause operation of two of the five digit-register relays. Relay RA released also operated RA1 which operates the next steering relay and, with five individual contacts, opens the five output leads of the counting relays. With this type of operation the digit register relays are required to operate during the operate time of RA1. Two other break-contacts on RA1 release the counting relays. The circuit is then ready for the next digit.

B5-2.13 TOUCH-TONE CALLING

Originating registers can also be equipped to handle TOUCH-TONE calling. An additional register group must be established in the DTM and is shown on SFD-B105. The TT OR, is capable of receiving both the TOUCH-TONE and dial pulse digits to the TOUCH-TONE customer that has a TOUCH-TONE and dial pulse set in his home. A description of the functions relating to TOUCH-TONE calling is as follows.

B5-2.13.1 General Operation (SFD-B507, 508, 509)

The translation and registration of a digit takes place as follows. The TT (TOUCH-TONE) receiver responds to the frequencies generated by the customers TOUCH-TONE set and furnishes output grounds to operate the translating relays in the translating circuit in accordance with the frequencies of the keyed digit. At the beginning of a digit the TT receiver also causes STR, steering relay to operate. Off-normal ground,

(SFD-B507) through the contacts of the operated translating relays, (SFD-B508) appears on two of the 0, 1, 2, 4 and 7 output leads which are connected by the steering relay to a digit register (SFD-B509) to cause operation of two of the five-digit register relays. The STR operated also operates the STRA, steering auxiliary relay, which in turn operates the next steering relay. At the end of a digit the output of the TT receiver is removed, thereby releasing the translating relays and the STR. The STR released releases the STRA which in turn releases the steering relay of the digit just registered. The circuit is then ready for the next digit.

B5-2.13.2 TOUCH-TONE Detection and Registration

For any digit, a combination of two audio frequencies is generated by the calling customer TOUCH-TONE set. Each combination of frequencies consists of one frequency out of a "high" group of three audio frequencies and one frequency out of a "low" group of four audio frequencies (see Table A). Twelve such combinations are thus available with this arrangement. Then of these are used to represent the digits 0 through 9. The remaining two combinations are designated * (asterisk) and # (number sign) and may be used for special purposes.

TABLE A

DIGIT	Frequencies Cycles Per Second		TT Receiver Output Leads Grounded		Translating Relays Operated		Output Leads Grounded
0	1336	941	HG2	LG4	Z2	Y9	4, 7
1	1209	697	HG1	LG1	Z1	Y0	0, 1
2	1336	697	HG2	LG1	Z2	Y0	0, 2
3	1477	697	HG3	LG1	Z3	Y0	1, 2
4	1209	770	HG1	LG2	Z1	Y3	0, 4
5	1336	770	HG2	LG2	Z2	Y3	1, 4
6	1477	770	HG3	LG2	Z3	Y3	2, 4
7	1209	852	HG1	LG3	Z1	Y6	0, 7
8	1336	852	HG2	LG3	Z2	Y6	1, 7
9	1477	852	HG3	LG3	Z3	Y6	2, 7
*	1290	941	HG1	LG4	Z1	Y9	
#	1477	941	HG3	LG4	Z3	Y9	

Associated with each TOUCH-TONE originating register is a TOUCH-TONE calling receiver circuit which detects the presence of TOUCH-TONE keyed digits and causes translating relays (SFD-B508/C5) to operate, corresponding to the frequencies of the keyed digit. Operation of the translating relays transfers the digital information into digit register units (SFD-B509). The end of a digit is recognized by the STRA steering relay which operates when a key is depressed at the customer set and remains operated until the key is released. This relay controls the transfer of digital information into the proper digit register.

B5-2.13.3 TOUCH-TONE Calling Receiver

The TOUCH-TONE calling receiver is bridged across the incoming T and R leads of the register circuit. Each keyed digit causes the TT receiver to ground one of the four LG1-4 leads, one of the three HG1-3 leads and the STR lead (SFD-B508/C5). The receiver is arranged to maintain these output grounds for a minimum of 50 milliseconds of time to insure that the digit has been registered and the digit register has been advanced. This action prevents a digit from being lost should a customer depress a key for a very short interval.

The grounded LG- lead operates one of the Y0, Y3, Y6, or Y9 translating relays and the grounded HG- lead operates one of the Z1, Z2, or Z3 translating relays. The frequencies received for each digit, the output leads grounded by the TT receiver, and the translating relays operated are as follows. The numerical designation of the operated Y0, Y3, Y6, or Y9 and Z1-3 relays may be added to obtain the corresponding digit for digits 1 through 9.

The receiver is arranged to detect TOUCH-TONE signals and to ignore other signals. It will provide an output of two digit signals and the steering signal for each digit received. The TOUCH-TONE receiver acts as a discriminator and will ground two of the digit leads when it detects a digit. In all other cases it will provide no output.

The MF relay also operates as soon as the first keyed digit is received (SFD-B508). The P2A operates also if the first digit is greater than one. The MF locks to an off-normal ground and informs the register that the call is being originated by a TOUCH-TONE customer. The P2A locks through a continuity transfer contact to an off-normal ground and causes the digit to be registered in the A-digit register unit. The P2A operated also opens the dial tone circuit, closes a ground supply for the output leads of the translating circuit and opens the operating circuit of the AS steering relay.

B5-2.13.4 Digit Translation

The digit translation circuit consists of the Y0, Y3, Y6, Y9, Z1, Z2, and Z3 relays. These relays are under control of the TT calling receiver output leads LG1-4 and HG1-3 and function to translate the 4 by 3

encoded information received from the TT receiver into 2-out-of-5 information required by the digit register units. The outputs of the translating relays appear on the 0, 1, 2, 4, and 7 leads which are connected to the proper digit register unit by the steering relays. The output leads are grounded as indicated in Table A.

If for any reason an unused combination of translating relays should operate, namely, Y9 and Z1 (asterisk) or Z9 and Z3 (number sign), the TBL punching will be grounded which will cause TBL to operate (SFD-B507). The TBL operates BT which will cause busy tone to be returned to the customer from the register.

B5-2.13.5 Digit Steering

The digit steering circuit serves to connect the output of the translating relays to the digit registers successively as the digits are keyed. The steering circuit is also used to indicate when keying is completed. This circuit consists of one relay per digit and the STS relay which grounds the M7 lead to the marker (SFD-C115) if a digit is stored in the L register. The advance of the steering circuit is under control of relay STRA.

B5-2.14 PRETRANSLATOR START (SFD-B510)

The main function of pretranslation is to determine from the first 2 or 3 digits dialed how many digits should be expected. Although the register may provide its own pretranslation, the SFD shows only pretranslation by connection to a pretranslator.[†]

With few exceptions, the CR is arranged to go to the pretranslator after dialing the C digit. Upon completion of counting the pulses for the C digit, operation of the RA1 relay operates the DS relay (SFD-B508). This operates the PST relay which locks (SFD-B510). The operation of the PST relay causes the OR to connect to the pretranslator as will be covered in SCD-B6 section.

If there are still any offices using 2-digit office codes, the OR is wired in those offices to go to the pretranslator after dialing the B digit when the CS relay operation operates the PST relay (SFD-B510).

As will be explained later, the output of the pretranslator operates one or none of the relays CMA, CMB, or CMC and may or may not operate the SD relay of the OR.

[†] Pretranslations within the OR may be covered in a subsequent issue of the SFD and SCD.

B5-2.15 MARKER START (SFD-B510)

Determination of when the OR should start for the CM is made by cross-connection from terminals B through 411 to terminal MST through DL shown on SFD-B510. Which of the terminals CM3A through DL are effective is controlled by the pretranslator output. SFD-B510 shows only one typical cross-connection from the G terminal to the CM2 terminal. This causes the MST relay to operate after 7 digits have been dialed (on other than 2-party or coin lines) provided the pretranslator did not operate any of the relays CMA, CMB, CMC, or SD in the OR. This is called a basic setting from the pretranslator.

On 2-Party or coin lines either a second party test or a coin test, must be made before the MST relay can operate.

B5-2.16 SECOND PARTY TEST (SFD-B503, B510)

If the 2P relay is operated, upon operation of the steering relay beyond the last digit expected, the TPB relay operates (SFD-B510). (Refer to sequence chart on SFD-B503.) The TPB relay operates the TPA relay which for the second time connects the TP relay to both sides of the line and opens the operate path of the TPD relay. If the tip party is off-hook, the TP relay operates. If only the ring party is off-hook, the TP relay may momentarily operate but should release before the slow-release TPD relay releases to operate the TPC relay. The TPC relay extends ground to operate the MST- relay to start the connection of the OR to the marker. The L relay is held operated during the second party test by a combination of TPB relay (operated) and either TPC or TPD relay (normal) until release of the TPA relay reconnects the L relay to the loop. If both the TP1 and TP2 relays are normal at the end of the second party test, an RP signal is transmitted to the CM. If both TP1 and TP2 relays operate, a TP signal is transmitted to the CM. If either relay is operated and the other normal, this is an indication of a party mismatch caused possibly by the tip party going off-hook after the ring party had initiated the call and had been recognized on the first party test. This condition causes both TP and RP leads to be grounded to the CM.

B5-2.17 COIN TEST

The originating register is arranged with several different options for coin tests. The SFD shows only the improved coin test arrangement which works with either dial tone first loop start lines or with coin first ground start lines.

Initially, when the register is seized for coin service, relay CN operates (SFD-B429) followed by the operation of the CNT2 and subsequently CNT3 relays (SFD-B509). The CNT2 relay is held operated over its operate path and a lock path controlled by the CNT1 relay. The CNT3 relay is held operated under control of the CNT2 relay. The primary function of relays CNT2 and CNT3 is to release, in sequence, after the called

number has been dialed and before the marker is called, thereby timing the coin test interval. Relays CN and CNT3 operated prepare the register for coin test by transferring the normal operate path of the MST relay to the CNT relay (SFD-B510). At the end of dialing, CNT operates over this path. The function of CNT is to hold the L relay operated (SFD-B509, 503) and then start the coin test cycle. The hold on L is needed to prevent its release during coin test. The CNT operated also locks relay RA1 (SFD-B510) and operates relay MST1 (SFD-B509). This action disables the digit counting and registration circuits. In addition, CNT operates CNT1. With both these relays operated, CNT2 begins to release. The CNT1 operated transfers the tip lead to ground test relay GT, opens the ring lead to prevent the holding ground on L from backing up through the loop to the GT relay, and recycles the TM timing circuit.

When the GT relay is initially connected to the external tip circuit, it may falsely operate due to line surge. If a coin has been deposited at the coin station, thereby grounding the tip lead, GT will operate or remain operated if it has falsely operated. If a coin has not been deposited, GT will not operate or will soon release if falsely operated. Since the final state of GT (operated or nonoperated) at the end of the coin test cycle determines the coin-present or not-present indication to the marker, the slow-release of CNT2 covers the period during which GT may falsely operate and release. Relay GT1 records the final state of GT during the slow-release interval provided by CNT3. The operation of GT1 is under control of both GT and CNT2. Once operated, GT1 locks. When CNT3 releases, it reestablishes the marker start circuit, causing operation of relay MST and summoning the marker. The GT1, if operated, grounds lead SCK to the marker and, if normal, grounds lead SCN.

An operate test of the GT relay is made before the register releases to check that GT is capable of operating under service conditions. This test is made on all coin calls when L releases and RL operates. The register will remain off-normal, if GT does not operate. The locking path of ON1 is closed through a front contact of CN and a back contact of GT1, so that if GT and GT1 fail to operate, ON1 will remain operated and the register TM timing circuit functions to cause an alarm.

To permit this arrangement to function with ground-start coin lines which have more sensitive line circuit relays requires that the L- relay of the OR be made more sensitive so as to operate on a lower value of line current than the line relay to prevent showering.*

* Showering occurs when lines become leaky as a result of rain or other conditions. If the line relay were more sensitive than the L or the OR, a connection would be established to the OR which releases because its L relay does not operate. Repeatedly, connection to an OR would be set up and released.

To increase the sensitivity of the L relay, the CN relay closes ground through resistance to apply current in the tertiary winding of the L relay in a direction to aid in operation of the L relay.

B5-2.18 ABANDONED CALL

B5-2.18.1 Dial Tone Marker Attached

If the customer abandons the call and replaces the receiver on the switchhook, the closure on the tip and ring conductors is opened. If this occurs before the dial tone marker has completed the dial tone connection, L will not operate to operate SR (SFD-B503) and ON1 (SFD-B511). When S1 releases after the release of F (SFD-B507), ON will release to release the connection (SFD-B423). On a 2-party line the first party test will be made before S1 and ON release. The TPA relay holds the S1 relay operated until the first party test is completed.

B5-2.18.2 After Dial Tone Marker Has Released

If the abandonment occurs after L, SR, and ON1 have operated (see sequence chart SFD-B509), L and SR will release. If abandonment occurs prior to completion of the first party test on a 2-party call, the first party test must be completed before the L relay is connected to the line to recognize the abandonment. On a coin call, if abandonment occurs during the coin test, release of the L and SR relays is delayed until completion of the coin test when the CNT relay releases. On noncoin calls, release of the SR relay operates the release relay RL directly (SFD-B510). On coin calls release of the SR relay operates the CR relay to cause coin return followed by timed operation of CR1 and CR2 relays (SFD-B509) to operate relay RL.

The RL relay opens the tip and ring leads (SFD-B503) to avoid breaking current at the crosspoints of the switches. It also opens the sleeve lead (SFD-B423) to release the dial tone connection. The RL relay locks to ground on the ON relay and opens one locking path for the ON1 relay. On coin calls there is another locking path through the GT1 relay normal. Operation of the RL applies a test condition to operate the GT relay which in turn operates the GT1 relay to release the ON1 relay. On 2-party calls the TP1 relay should have already operated before the abandonment could have been recognized. This would open the second locking path for the ON1 relay on 2-party calls.

The ON1 relay releases the ON relay to cause release of all the relays of the register so that it is ready for the next call.

B5-2.18.3 Completing Marker Attached

If the completing marker has been engaged before the customer disconnects, the L relay will be held over the L lead to the connector where it is connected to the TM lead which is connected to ground through

front contacts of MST (SFD-B503). The connection to the trunk will be set up in the usual manner but, since the customer loop is open, the trunk connection will immediately release.

B5-2.19 COIN RETURN ON ABANDONED CALL

The CN relay will have been operated in the OR by the DTM on a coin line call. If the call is abandoned, release of the L relay releases the SR relay (SFD-B503). Release of the SR relay operates the CR (coin return) relay (SFD-B510). The sequence chart (SFD-B509) should be followed for the balance of this description. Operation of the CR relay operates the MST1 relay (SFD-B511), starts the CR1 timer (SFD-B509), opens the operate circuit for the MST relay to prevent seizure of a completing marker during the coin return cycle, disconnects the L relay from the ring lead, removes ground from the tip lead, and prepares for application of coin return potential to the tip lead.

Operation of the MST1 relay closes either +130 or -130 volts (depending on whether positive or negative coin return is used in the area) through the CR1 resistor to the CRL resistor to ground. These resistors reduce the voltage applied to the tip side of the line for coin return. After 500-780 milliseconds the CR1 timer operates the CR1 relay which opens the coin return potential.

Operation of the CR1 relay starts the CR2 timer. After 470 to 750 milliseconds, the CR2 timer operates the CR2 relay which operates the RL relay to release the register.

B5-2.20 REGISTER TIME-OUT

The originating register time measure (TM) timer (SFD-B511) times for various functions of the register to be completed. If they are completed within the time-out interval, the TM timer recycles itself for timing the next function. If the function is not completed, the timer times out and causes the action shown in the table of Note 1 (SFD-B511).

The nonoverload (OVL relay normal) time interval of the TM timer is a nominal 25 seconds for each function timed. If all originating registers are busy (SCD-B5-2.20), the group busy circuit operates the OVL relay of all registers in the group. This reduces the timing for dialing of the first digit to a nominal 12.2 seconds and of each subsequent digit to a nominal 5.7 seconds.

B5-2.20.1 Detailed Operation

Operation of the CN relay operates the TMA relay on its primary winding and in turn operates the TMB relay and starts the TM timer. If the second pulse of a first digit has not been received before the TM timer times out, the TM relay operates the TM1 relay which operates the MST relay to start connection to a completing marker.

If the second pulse of the first digit is received before the TM times out, operation of the P2A relay (SFD-B504, B506, B507) operates the PD relay and opens the holding path for the TMA and TMB relays. The release TMA relay stops and recycles the TM timer. When the slow release TMB relay releases, it reoperates the TMA relay to restart the TM timer. If the OVL relay is operated, the operation of the PD relay reduces the TM timing interval from a nominal 12.2 seconds for the first digit to 5.7 seconds for each subsequent digit. If the OVL relay is not operated, the timing interval remains at a nominal 25 seconds for all digits. When the RAl relay reoperates after the last pulse of the first digit, the TMB relay reoperates.

For each subsequent digit, release of the RAl relay at the beginning of the first pulse (SFD-B504, B506, B506) opens the holding path for the TMA and TMB relays. As described above, release of the TMA relay stops and recycles the TM timer. Release of the slow-release TMB relay reoperates the TMA relay to restart the TM timer. Thus a timed interval is allowed for each digit to be dialed.

When the TM timer times out, it operates the TM relay which grounds an LP lead to light a TO (time-out) lamp associated with the OR at the JLK panel. It also operates a DLA relay at the JLK panel over the ALM lead. The ALM lead is multiplied to all originating and incoming registers and senders in the marker group. The DLA relay starts the time-out alarm timer (TOA). Normally the DLA relay will only operate momentarily since the OR is released shortly after its time measure timer times out. If there is a trouble condition which holds the DLA relay operated long enough (10.5 to 15.7 seconds), the TOA timer operates the TOA relay which lights the TOA (time out alarm) lamp and operates the MJ relay of the alarm circuit over the MJ lead. The MJ relay lights the aisle and main aisle major alarm pilot lamps and causes a major audible alarm to be sounded (not shown).

B5-2.21 OVERLOAD CONTROL (SFD-B511)

If no trunk link frame having an idle OR is available (SCD-B2-1.3), the TBT timer operates the TBTA relay (SFD-B111). When this occurs, the DTM (SFD-B511) grounds an RB (register busy) lead to the group busy circuit associated with that group of ORs to operate an RB1 relay which operates an RB2 relay and grounds an ORB lead to operate a B- relay in the traffic register circuit. The B- relay locks under control of a TR-AR key at the JLK panel or, if provided, under control of the alarm sending circuit. The B- relay lights an ORB (originating registers busy) lamp at the JLK panel and opens one of the locking grounds for the RB1 relay. The RB2 relay in operating locks and removes the second locking ground for the RB1 relay so that it releases when the DTM removes ground from the RB lead. The RB2 relay operates relays RB3-6. Relays RB2-6 ground OVL leads to each of the originating registers in the group to reduce timing intervals as described in SCD-B5-2.19.

When the DTM releases the RB1 relay with the RB2 relay operated, the release (RT) timer is started. The release timer times for 9.6 to 15.3 seconds then operates the RT relay which opens the locking path to release the RB2 relay which releases the RB3-6 relays to remove ground on the OVL leads. If a DTM should reoperate the RB1 relay before the RT timer times out, the RC capacitor is discharged to recycle the timer. When the RB1 relay again releases, the timer is restarted.

Operation of the B- relay of the traffic register circuit extends battery from the JLK panel to operate the MN relay of the alarm circuit which lights aisle and main aisle minor alarm pilot lamps associated with the aisle in which the JLK panel is located. The MN relay operates the MN1 relay which causes a minor audible alarm to be sounded (not shown). Thus, the audible alarm calls attention to the fact that there is a problem. The aisle pilots indicate the aisle in which the JLK panel is located and the previously mentioned ORB lamp indicates an all originating register busy condition. Momentary operation of the TR-AR key will restore the audible alarm and extinguish the lamps.

SECTION B, PART 6

PRETRANSLATION

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B6 PRETRANSLATION

From the A, B, and C dialed digits, it is possible, in most cases, to determine the total number of digits required to be dialed. The OR needs this information so that it can request connection to a completing marker as soon as the required number of digits have been dialed. Determination of this information from the A, B, and C digits is called pretranslation. Pretranslation may be performed within the OR or by pretranslator circuits* common to all ORs.

In offices where the determination of the number of digits required for various codes is not economical or, in some cases, impossible when using the translators built into the individual registers, a pretranslator circuit is provided. This circuit can translate as many codes as required, and is common to the group of registers. This translation is transferred to the register so that the register can connect to the marker after the proper number of digits have been registered. The register makes a multiple lead connection to the pretranslator by means of the pretranslator connector. The register will connect to the pretranslator after three digits have been registered.†

B6-1 CONNECTOR ACCESS TO PRETRANSLATORS (SFD-B603)

The block diagram (SFD-B603) illustrates the connector access arrangements between ORs and PTRs. As many as three connectors may be provided. The ORs associated with each connector are divided into as many as three subgroups with a maximum of 24 ORs to a subgroup. In order to connect a register to a pretranslator, it is necessary to operate register connector relays (PR--), subgroup connector relays (G--), and pretranslator connector relays (P--).

B6-2 SEIZURE OF A PRETRANSLATOR BY AN ORIGINATING REGISTER (SFD-B602, B604)

The following description assumes that the connection is made to the pretranslator after the third digit has been registered in the OR.

* This issue of the SFD and SCD deals only with common pretranslator circuits. A description of pretranslation within the OR may be added in a subsequent issue.

† There may still be a few offices having 2-digit office codes. In these cases the OR would connect to the pretranslator after the second digit. This SCD will only discuss operation with 3-digit office codes.

When the C digit has been registered in the OR, its DS relay will operate. The DS relay operates the pretranslator start relay PST (SFD-B512) which locks and starts selection of a pretranslator by connecting battery to the start (ST) lead to the pretranslator connector circuit originating register part (SFD-B604). The PST relay grounds the TM lead to the pretranslator connector pretranslator part to operate the TM relay (SFD-B611). The TM relay operates the TMI relay which starts the PRTC work timer (SFD-B609). The PST relay also opens the operating circuit of the overload timing (OVL) relay (SFD-B513) to ensure that register timing during the pretranslator stage of the call will be at the 25-second nominal rate.

Three separate preference controls are used to operate:

- (1) Register connector relays
- (2) Subgroup connector relays
- (3) Pretranslator connector relays.

B6-2.1 PREFERENCE FOR OPERATION OF REGISTER CONNECTOR RELAYS

Reference should be made to the sequence chart (SFD-B602).

B6-2.1.1 PRS- Relay Operate Chain

In periods of very light traffic (assuming only one OR at a time is operated in a subgroup), when the OR applies start battery to bid for a pretranslator, PRS relay operation is straightforward. Start signal battery from the OR is applied to the associated PRS- relay winding which is connected through the PRS- operate chain* to ground at the winding of the first PRS- relay in the operate chain (shown on SFD-B604 as associated with last OR). In periods of heavy traffic, two or more ORs may initiate requests simultaneously or in rapid succession.

Assume that the first OR and an intermediate OR (SFD-B604) initiate simultaneous requests (apply start battery). Both PRS- relays will operate and lock. If, however, the intermediate OR had initiated a request slightly ahead of the first OR, the PRS- relay for the first OR could not have operated because ground for its winding would have been opened by the operate chain at the PRS- relay for the intermediate OR. On the other hand, if the first OR initiated a bid first, any other OR ahead of it in the operate chain can subsequently operate its PRS- relay.

B6-2.1.2 PRS- Relay Work Chain

Since it is possible to operate two or more PRS relays at the same time, a work chain determines which PRS- relay does the work. The work chain

* Note that there are paralleled break contacts in the operate chain. This is done in many of the paths of both the pretranslator connector and the pretranslator to improve reliability.

progresses through contacts of the PRS- relays in the opposite direction to the operate chain, starting with ground at a contact of the PRS- relay for the first OR. If the PRS- relay for the first OR is operated, the work chain ground will operate the PRA-, PRB-, and the series GS- relay whether or not other PRS- relays are operated within the subgroups as will be explained in SCD-6-2.1 the above is true for 0 subgroup in light or heavy traffic. For other subgroups there is further control which may delay GS- relay operation in heavy traffic for other than the 0 subgroup.

When an OR which has its PRA-, PRB- connector relays operated has received its information from the pretranslator and opened the start lead, the PRS- relay for that OR releases. If there are any other PRS- relays operated, the next PRS- relay in the work chain which is operated now functions as described to operate its PRA-, PRB- relays and the same GS- relay. This continues until all operated PRS- relays have been served.

B6-2.2 PREFERENCE FOR OPERATION OF SUBGROUP CONNECTOR RELAYS

B6-2.2.1 GS- Relay Operate Chain

Although there is no actual chain of contacts in the GS- relay operate path, there are contacts of GS- relays in the operate path of each GS- relay which serve the same purpose.

In periods of very light traffic (assuming only one OR in a connector applies start battery to bid for a pretranslator), GS- relay operation is straightforward. When a PRS- relay operates, it operates PRA-, PRB- relays and the series GS- relays. In periods of heavy traffic, PRS- relays may operate in two or three subgroups at the same time or they may operate in rapid succession.

Assume that the PRS- relays in subgroups 0 and 2 operate at the same time. Relays PRA-, PRB-, and GS- relays for both subgroups will operate. GS2 relay will lock and both GS- relays will remain operated. If GS0 relay had been operated slightly before GS2 relay, the GS2 relay operate path would have been opened by a contact of GS0. If, however, GS2 relay had operated first, GS0 could have subsequently been operated.

B6-2.2.2 GS- Relay Work Chain

Since it is possible to operate two or more GS- relays at the same time, a work chain determines which GS- relay does the work. The work chain progresses through contacts of GS- relays in the reverse direction to the effective operate chain; that is, the higher-numbered subgroup has work preference while the lower-numbered subgroup has operate preference. If the GS- relay for subgroup 2 has its GS2 relay operated, the GS2 relay will operate whether or not other GS- relays are operated. When the OR having its PRA-, PRB-, and GS- relay operated is finished, it causes GS- to release. If there is any other GS- relay operated, the

next GS- in the work chain which is operated now functions as just described to operate its GC- relay. This continues until all GS- relays have been served.

B6-2.3 PREFERENCE FOR OPERATING PRETRANSLATOR CONNECTOR RELAYS

Three chain circuits are used in selecting a pretranslator and closing the PC- connecting relays. The operation of this portion of the pretranslator connector is similar to operation of the line link marker connector.

B6-2.3.1 CB- Relay Chain (SFD-B605)

An operated CB- relay indicates that the associated pretranslator is busy to the connector. A CB- relay operated for a preferred pretranslator advances the start lead to the next preferred pretranslator (SFD-B605). If the CB relay for that pretranslator is operated, the start lead is transferred to the next preferred, etc. Usually only two pretranslators are provided.

B6-2.3.2 PS- Relay Operate Chain

In periods of very light traffic (and assuming no pretranslators busy), PS- relay operation is straightforward. When PRA-, PRB-, and GC- relay have operated, start battery is applied to the STA lead if the Z relay is normal and to the STB lead if the Z relay is operated (SFD-B604). (The Z relay is operated on every other call.) A start signal on either STA or STB operates the PS- relay associated with the PS- terminal to which the start lead is cross-connected.

In periods of heavy traffic, one or more pretranslators may be busy and calls may initiate from more than one connector simultaneously or in rapid succession.

Assume that the STA lead of connector 1 and the STB lead of connector 1 are closed simultaneously (SFD-B605). The PS0 relay in both connectors will operate to the PSG ground in the pretranslator. An early make-contact on the PS0 relay for connector 0 will provide locking ground for that PS0 relay before the break-contact for the PS0 relay in connector 1 opens the operate path from the PSK ground. Thus, both relays will operate and lock.

If, however, connector 1 closed its start lead slightly ahead of connector 0, the PS0 relay for connector 0 could not operate. If, on the other hand, the 0 connector closed its start lead first, a subsequent closure by the 1 connector could operate its PS0 relay.

B6-2.3.3 PS- Relay Work Chain (SFD-B605)

Since it is possible to operate two or more PS- relays at the same time, the work chain determines which PS- relay does the work. Ground for the

work chain initiates in the pretranslator at the PCG cross-connection. It should be noted that the work chain proceeds through contacts of the PS- relays in a reverse direction to the preference PSK chain. Contacts on the PS0 relay for connector 0 are therefore enabled to operate connector relay PC0 whether or not any other PS0 relay is operated (SFD-B605). The PC0 relay operates PA0 and PB0 relays which in turn operate the PCA0 relay. The PC0 relay also operates the PK relay (SFD-B609).

Upon operation of the PCA0 relay, the MB relay of pretranslator 0 is operated (SFD-B605). The MB relay operates CBO relays in connectors other than the one which seized the pretranslator. Resistance battery to the winding of this CBO relay is shunted by the operated PC0 relay. If this CBO relay were allowed to operate, the start battery power over which the PS0 relay operated would be opened.

If two or more PS0 relays had operated, the start battery lead for each connector which failed to get a pretranslator would be advanced to the next preferred pretranslator. If, however, no other pretranslators were available, the calls would have to wait until one becomes available and would again bid for preference.

When a PS- relay operates, it releases normally operated check relays PC and PS for the associated pretranslator (SFD-B605). Release of either of these relays or operation of the PC- connector relay operates the TM relay of the pretranslator (SFD-B608). Operation of the TM relay starts the WT (work timer) of the pretranslator (SFD-B609).

Release of the PS or PC check relays or operation of the TM relay lights an in-use lamp PRT at the JLK panel (SFD-B611).

B6-3 W AND Z RELAY CIRCUIT FOR TRANSFERRING START LEADS (SFD-B604, 609)

If only one start lead were provided, then, under light traffic conditions, a particular connector might seize the same pretranslator for every usage. If this were in trouble, all calls from that connector might be blocked. To prevent this and also to reduce the adverse effects of other circuit failures, two start leads are provided for each connector. By alternating the use of these start leads, two pretranslators serve alternately as first choice thereby providing more even wear on the connectors. This transfer is accomplished with a W and Z relay combination. The operation and release of relay Z provides the necessary transfer.

In the following description, assume that relay TRS (Transfer Start) is normal.

B6-3.1 FIRST CONNECTOR USAGE (SFD-B609)

Assume that both W and Z relays are normal. Operation of the PC- relay for any pretranslator in the connector applies ground to the windings of both the W and the Z relays (SFD-B609). A break-contact of the Z relay also closes ground to the other side of the Z relay shunting down the resistance battery to the winding, so that both sides of the winding are at ground potential. Only the W relay can operate. The W relay locks to ground. At the end of the pretranslator usage, the PC- relay releases removing the ground which shunted down battery to the Z relay which now operates.

B6-3.2 SECOND CONNECTOR USAGE (SFD-B609)

The next time a PC- relay operates in the connector, it applies ground through a make-contact of the Z relay to shunt down the resistance battery to the W relay causing it to release (SFD-B609). When the PC-relay releases, it removes ground from the Z relay winding causing it to release. Thus, the W and Z relays are alternately operated on one call and released on the next.

B6-4 CONNECTOR TIMING

When any OR in a connector operates its PST relay, it grounds the TM lead to the connector (SFD-B609). The TM relay operates the TMI relay and the TRS1 relay. These relays start two timers in the connector.

B6-4.1 CONNECTOR TRANSFER START TIMER

The transfer start timer allows an interval of 150 to 360 milliseconds for the connector to establish a connection to a pretranslator. The timer is stopped when either the MB relay or the pretranslator operates (SFD-B605) which releases the TRS1 relay (SFD-B611) or the PK relay of the connector operates (SFD-B609) which releases the TM relay and, in turn, releases the TRS1 relay (SFD-B611). In either event, the PC-relays of the connector would have operated indicating that a connection to the pretranslator had been established.

If the transfer start timer is not stopped within its timeout interval, the TRS relay is operated (SFD-B609). The TRS relay locks under control of the TMI and PK relays and it opens the start lead STA or STB which previously used and closes the other start lead (SFD-B604). If the call has proceeded to the operation of the PRA-, PRB-, and GC- relays which close battery to the STA and STB leads, a new attempt to connect to a pretranslator using the other start lead will be made. If a pretranslator is seized using the other start lead, a TRS signal is transmitted to the pretranslator (SFD-B611) which will cause it to produce a trouble record showing a TRS punch. If, however, the call is blocked prior to operation of the GC- relays, the transfer of start leads will have little effect.

B6-4.2 CONNECTOR WORK TIMER (SFD-B609)

The work timer has a longer timing interval (0.93 to 2.22 seconds) than the transfer start timer and covers a failure to connect to a pretranslator after the transfer start timer has timed out. The work timer is started when the TM1 relay operates (SFD-B609) and continues to time until the PK relay operates indicating a connector PC- relay has operated. Operation of the PK relay recycles the timer and also releases the TM relay and in turn the TM1 relay. When the TM1 relay releases with the PK relay operated, the timer is restarted to time for release of the connector as indicated by release of the PK relay. If the pretranslator should take a trouble record while the timer is timing for release of the connector, operation of the PRA relay in the MTFC operates the RCKK relay of the pretranslator (SFD-B611) which reoperates the TM1 relay of the connector and recycles the timer. Upon completion of the trouble record, the TM1 relay releases and again starts the timer.

If the work timer times out, it operates the CA relay which locks under control of the PRTC-AL alarm release key at the JLK panel. The CA relay also lights a PRTC- lamp at the JLK panel. This lamp is lighted momentarily on each call during the time that the PK relay is operated. When the CA relay operates, the lamp remains steadily lighted until released by momentary operation of the PRTC-AL key at the JLK panel. The CA relay also closes resistance battery from the JLK to operate the MJ relay in the alarm circuit to sound a major alarm.

B6-5 FALSE GROUND ON PRL OR RLK LEADS

The register circuit release relay is double-wound. The PRL lead connects to one winding and the RLK lead to the other. A trouble ground on either of these leads would cause calling registers to be released falsely. Such a condition, however, is indicated as follows.

For each register subgroup, the PRL and RLK leads are connected through normal contacts of PSR and GCA to the primary winding of the CA relay. A false ground on these leads with the corresponding GCA relay normal consequently causes the CA relay to operate.

The PRL and RLK leads between the subgroup connector relays and the pretranslator connector relays are also connected to the CA relay through normal contacts of PK, so that the CA relay will operate if these leads are falsely grounded.

The CA relay operated as above performs the function described previously under the work timer.

B6-6 BASIC SETTING RELEASE

A basic setting release jack BSR is provided in the jack, lamp, and key circuit for each register subgroup. When a plug is inserted in this jack, ground is connected to the BSR lead, operating the BSR- relays for the subgroup (SFD-B609). This relay operated returns ground to the jack, lamp, and key circuit over lead SGL to light a guard lamp, and it disconnects the PRL and RLK leads from the CA relay. It also connects ground to the PRL and RLK leads and removes ground from the G1 and G2 leads. This causes calling registers in the subgroup to release immediately under operation of their PRS relays, without any further operations taking place.

Registers released in this manner will call the marker in accordance with the number of digits required for the basic setting. For domestic calls this is usually 7 digits and corresponds to the number of digits used for the home office. For IDDD calls a repetitive timer is employed after 7 digits have been registered. Domestic calls normally using the regular pretranslator, and requiring more or less digits than the number represented by the basic setting, will not be completed, while IDDD calls will be completed.

The basic setting release feature does not interfere with zero operator calls as they do not use the pretranslator. This applies also to calls using 11X codes as service codes.

In view of the service reaction caused by this feature, it is to be used only when a greater reaction would be caused by removing the registers from service.

The PRL and RLK leads are disconnected from the CA relay to prevent operation of the CA relay and the consequent sounding of the major alarm while the make-busy feature is in operation.

B6-7 INFORMATION RECEIVED BY PRETRANSLATOR

B6-7.1 LEADS FROM REGISTER THROUGH CONNECTOR

The register circuit connects grounds to leads A0, 1, 2, 4, and 7; B0, 1, 2, 4, and 7; and C0, 1, 2, 4, and 7, in accordance with the A, B, and C digits which it has received on a 2-out-of-5 basis. The connector closes these leads through to the pretranslator, thereby causing operation of relays AC-, BC-, and CC- which correspond to grounded leads (SFD-B603).

If the A digit preceded by an 11 foreign area directing code is to be translated, the LT and 11X relays are provided. In this case the register connects ground to the LT lead on calls requiring translation of a

home area office code or an X11 code, or to the 11 lead for translation of the A digit preceded by an 11 foreign area directing code. This causes the operation of relay LT or 11X.

B6-7.2 LEADS CLOSED BY CONNECTOR

On second trial calls, the connector closes ground to the TR2 lead, operating the TR2 relay (SFD-B609). This relay performs no useful functions, if the call is properly completed. Its action under trouble conditions is covered later.

If a pretranslator is selected after the transfer start feature in the connector has operated, ground is closed to the TRS lead, operating the TRS relay (SFD-B611). This causes a trouble record to be taken as herein described.

B6-8 TRANSLATION

The following paragraphs describe the cross-connection for this circuit and the operation of the translation features for home area office codes in areas where all such codes consist of three digits. The translation for X11 codes, 11 foreign area directing codes and restricted codes, and the treatment of certain vacant codes as applying to all areas, is also described.

As a result of translation, ground is connected to one of a maximum of 10 transmitting punchings BS- and CM- (SFD-B607), the punching used for each codes being in accordance with local requirements. These punchings represent start indexes and control the transmission of information to the register as follows:

- (a) Point BSS represents the basic setting. It is used also for foreign areas requiring the same total number of digits, exclusive of an 11 prefix.
- (b) Point BSP provides for the number of digits corresponding to the basic setting with station delay. It is used for codes to manual offices with station letters, having party lines which require this setting.*
- (c) CMS3 signals the register to call the marker, without returning a coin, after 3 digits have been dialed.
- (d) CMP3 signals the register to call the marker after 3 digits have been dialed, but before doing so it signals the register to return the coin on coin lines.

* Since there are now few if any No. 5 Crossbar offices having dial access to manual offices, these cross-connections are seldom used.

- (e) CMSA and CMSB are used for additional settings and may represent any numbers of digits, except ten, without stations delay, as determined by the originating register cross-connections.
- (f) CMSC is used for additional settings and may represent any numbers of digits, including ten, without stations delay as determined by the originating register cross-connections.
- (g) CMPA, CMPB, and CMPC represent the same numbers of digits as for the corresponding S punchings, but in addition set the register for stations delay.*

The operations involved in transmitting the previous information and additional features of the circuit are covered in the following sections.

B6-8.1 METHOD OF TRANSLATION (SFD-B606)

Since practically all No. 5 Crossbar offices are now arranged to use only 3 digit office codes, neither this description nor the SFD show 2 digit code options.

If local translation is required on a call (LT[†] relay operated by originating register), the pretranslator translates the 3 digit office code comprised of the A digits 2-9, the B digit 0-9, and the C digit 1-9 (or 0-9 if the office is arranged to use office codes with 0 in C digit). The end result as described in SCD-B6-7.1 is to be able to inform the OR of how many digits it should expect and in some cases whether or not to return a coin or coin lines.

The B digit which is received in a 2/5 code is translated into a 1/10 code to operate one of the sets of relays B0, BA0, CZ0 through B9, BA9, and CZ9 (SFD-B606). The three relays operated in series are required to provide sufficient contacts to perform subsequent portions of the over-all translation.

One through 9 of the C digit is translated into two separate 1/3 codes (SFD-B606) as follows:

<u>C Digit</u>	<u>Relay</u>	<u>C Digit</u>	<u>Relays</u>
1, 2, or 3	CR	1, 4, or 7	CU, CUA
4, 5, or 6	CS	2, 5, or 8	CV, CVA
7, 8, or 9	CT	3, 6, or 9	CW, CWA

* Since there are now few if any No. 5 Crossbar offices having dial access to manual offices, these cross-connections are seldom used.

† In some cases, only local translation is required and the LT relay is not provided. In this case, most of the leads which would go through its contacts are looped.

The 0 of the C digit is translated to operate the CZC relay if the office is arranged to use office codes with 0 in the C digit. If the office is not arranged to use office codes with 0 in the C digit, the 0 translation grounds the VCR terminal which, as will be covered later, is cross connected to treat 0 in the C digit as a vacant code.

Translation of the A digit is combined with the results of the previous two translations. (It should be noted that there will never be a 0 or 1 in the A digit when local translation is required since the OR will not connect to a pretranslator if there is a 0 in the A digit and will not store a 1 in the A digit.)* The first portion of this translation (SFD-B606) results in grounding of one of the terminals 20R through 99T or (if the office uses codes with 0 in the C digit) one of the terminals 200 through 990 is grounded.

Each of the 80 terminals 200 - 990 represents an individual code with a C digit 0.

Each of the 240 terminals 20R through 99T represents any of 3 codes as follows:

The first digit of the terminal designation is the A digit, the second is the B digit, and the letter indicates the C digit as below:

R = C1, 2, or 3
S = C5, 5, or 6
T = C7, 8, or 9

Further translation of this output is required to sort each code into 1 of 3 categories. For this purpose, there is provision for cross-connection from the 20R through 99T terminals to terminals P0-26.

Typical cross-connections are shown on SFD-B606.

Assume that each of codes 291, 292, and 293 represented by terminal 29R (SFD-B606) require that the register wait for 7 digits. Refer to Table A of Note 2 on SFD-B610. Terminal 29R should be cross-connected to terminal P0.

Assume that of the three codes represented by terminal 20S:

* This is not true if two digits 1 are dialed first as a directory code. In this case, however, the OR will signal the pretranslator for use of the 11 translator rather than the LT translator.

204 is an area code requiring 10 digits.
205 is an area code to a manual office which may require
either 10 or 11 digits.†
206 is a vacant area code (3 digits).

Refer to Table B of Note 2 on SFD-B610. Terminal 20S should be cross-connected to terminal P5. (Code 204 will be closed to terminal W1 by operation of the CU relay; code 205 will be closed to terminal W2 by the CV relay; and code 206 will be closed to terminal W3 by the CW relay.)

Similarly, if it is assumed that the three codes associated with terminal 92T are all vacant office codes (3 digits), Table A of Note 2 on SFD-B610 shows that terminal 92T should be cross-connected to terminal P26 which connects directly to the W3 terminal.

If the office does not use area codes, the W1, W2, and W3 terminals are cross-connected to BS- or CM- terminals (B607) in accordance with Note 1 on SFD-B610. Since most offices do use area codes, the columns in tables associated with offices which do not use office codes have been cross-hatched.

B6-8.1.1 Segregation of Office Codes and Area Codes

In offices which use area codes, a further translation is required to handle office codes and area codes differently.* In this case terminal W1 is connected to WA and W2 is connected to WB. If the B digit is either 0 or 1, the CZ0 or CZ1 relay connects the W1 terminal to W5 and the W2 terminal to W7. If the B digit is 2-9, the CZ2-9 relays connect the W1 terminal to W4 and the W2 terminal to W6. Cross-connections from the W3, W4, W5, W6, and W7 terminals should be made as shown in Note 1 of SFD-B610.

B6-8.1.2 Codes With 0 in C Digit

As previously mentioned, codes with 0 in the C digit cause one of the 80 terminals 200-990 to be grounded. These terminals should be cross-connected as shown in Note 1 of SFD-B610.

† Even though there are few if any manual offices left, this example is used to illustrate the additional flexibility that is still included in the pretranslator even though no longer required.

* Generally area codes can be distinguished from office codes because they have either 0 or 1 in the B digit. Eventually it is planned that office codes and area codes will be interchangeable; that is, any combination of 3 digits could be either an office code or an area code. Interchangeable codes will not be covered in this issue of the SFD or SCD.

B6-8.1.3 3-Digit Service or Operator Codes X11

Whenever the B digit and the C digit are both 1, the regular B and C digit translators are disabled since they both require that either a BC1, 4, or 7, or a CC1, 4, or 7 relay be operated and neither will be operated if both the B and C digits are 1 (SFD-B606). Instead the X11 terminal is grounded regardless of what the A digit is. All X11 codes are either 3-digit service calls or vacant codes and are handled in the same manner. Terminal X11 should be cross-connected as shown in Note 1 of SFD-B610.

B6-8.1.4 Foreign Area Directing Codes†

When the originating register grounds the 11 lead instead of the LT lead, the LT translator is not enabled. Instead, translation of the A digit causes one of the terminals 11X0-9 to be grounded. These terminals should be cross-connected in accordance with Note 1 of SFD-B610.

B6-9 INFORMATION TRANSMITTED TO REGISTER

As previously described the translation of a code causes ground to be connected to one of a maximum of 10 transmitting punchings BX- and CM-. These punchings are used as follows for transmitting information to the register.

- (a) Point BSS represents the basic setting for 7 digits. It is used also for foreign areas requiring 7 digits, exclusive of an 11 prefix.
- (b) Point BSP‡ provides for the number of digits corresponding to the basic setting with stations delay. It is used for manual offices and foreign areas requiring this setting.
- (c) CMS3 signals the register to call the marker, without returning a coin, after 3 digits have been dialed. It is used for vacant and for X11 service codes and ABX manual straightforward codes if the register is not to return a coin before calling the marker.

† The use of the 11 digits as directing codes has diminished to the point that very few No. 5 Crossbar offices still use it. For this reason the portion of the table in Note 1 of SFD-B610 relating to 11X directing codes has been cross-hatched.

‡ Terminals BSP, CMPA, CMPB, and CMPC provide stations delay which is only required for codes to manual offices. Few if any No. 5 Crossbar offices still require stations delay.

- (d) CMP3 signals the register to call the marker after 3 digits have been dialed, but before doing so to return the coin on coin lines. It is used for vacant codes and X11 service codes, and for X11 and ABX manual straightforward codes when they require this feature.
- (e) CMSA and CMSB are used for additional settings and may represent any numbers of digits except ten without stations delay, as determined by originating register cross-connections.
- (f) CMSC is used for additional settings and may represent any numbers of digits, including ten, without stations delay, as determined by the originating register cross-connections.
- (g) CMPA*, CMPB*, and CMPC* represent the same numbers of digits as for the corresponding S punchings, but in addition set the register for stations delay.

B6-9.1 CLOSURE OF TRANSMITTING LEADS (SFD-B607)

Closure of ground to one of the above punchings causes one of relays BS, CM3, CMA, CMB, or CMC, and one of relays SW or PW to operate in series with the primary winding of XR, to battery through TM relay operated. The XR relay does not operate except under trouble conditions as described later. The SW relay operates if the secondary winding of the BS relay or a CM- relay is involved. If it operates, it, in turn, operates SW1. The PW relay operates, operating PW1, if the primary winding of BS or CM- is used.

If one of the relays CM3, CMA, CMB, or CMC operates, it closes ground through the winding of CCM, normal contacts of KTR, through its own operated contacts, to the correspondingly designated lead to the pretranslator connector circuit. If the PW1 relay operates, ground is closed through the winding of CSD, normal contacts of KTR, operated contacts of PW1, to the SD lead to the pretranslator connector circuit. Double contacts, connected in series or in parallel, are used at a number of points in this circuit to guard against failures which would otherwise occur because of a locked contact or an open contact. This applies in particular to failures in the checking features which would make them inoperative.

* Terminals BSP, CMPA, CMPB, and CMPC provide stations delay which is only required for codes to manual offices. Few if any No. 5 Crossbar offices still require stations delay.

The association of the aforementioned terminals, relays and leads is as shown in Table E

TABLE E

Punchings	Relays Operated	Leads Closed
BSS	BS, SW, and SW1	None
BSP	BS, PW, and PW1	SD
CMS3	CM3, SW, and SW1	CM3
CMP3	CM3, PW, and PW1	CM3, SD
CMSA	CMA, SW, and SW1	CMA
CMPA	CMA, PW, and PW1	CMA, SD
CMSB	CMB, SW, and SW1	CMB
CMPB	CMB, PW, and PW1	CMB, SD
CMSC	CMC, SW, and SW1	CMC
CMPC	CMC, PW, and PW1	CMC, SD

The register circuit is equipped with CM3 and SD relays, and CMA, CMB, and CMC relays, if required, which correspond to the above leads and operate from grounds connected thereto through the windings of relay CCM, normal contact of XR and CSD, as previously described. Cross-connections in the register cause it to call the marker after 7 digits, in accordance with the basic setting, if no leads are grounded. If the CM3 lead is grounded, this basic setting is cancelled and the marker is called after three digits. Ground connected to one of leads CMA, CMB, or CMC also cancels the basic setting and causes the marker to be called at any other desired points as determined by cross-connections in the register. Connection of ground to the SD lead alone causes stations delay to be provided in connection with the number of digits required for the basic setting. The SD lead in combination with CMA, CMB, or CMC adds stations delay to the values assigned thereto. The SD lead in combination with CM3 causes a coin to be returned on coin lines.

If the register transmits more than 2/5 code digit indications to the pretranslator, the pretranslator will detect trouble as described in SCD-B6-12. The register will be released with none of its CM- relays operated (basic setting). This will cause the register to select a marker after the number of digits dialed is the number dialed for the majority of the calls. All such calls will be completed satisfactorily. Stations delay will be inserted where this signal is received from the pretranslator.

6-10 CHECK OF TRANSMITTING LEADS USED AND RELEASE OF CIRCUIT

6-10.1 CONTINUITY CHECK (SFD-B607)

Relay CCM is provided to check the continuity of lead CM3, CMA, CMB, or CMC on calls requiring one of these leads. Relay CSD is provided to check the continuity of the SD lead on calls requiring it. These relays operate in series with a CM- relay or the SD relay in the register circuit upon closure of the paths described in 6-8.2, if the associated leads are continuous through the connector circuit and through the windings of the register circuit relays to battery.

6-10.2 CONTROL OF CONNECTOR RELEASE AND RESTART

Operation of PW1 or SW1 or both causes HD to operate (SFD-B608). This path goes through LSD and LCM normal so that the circuit will fail and call for a trouble record if either or both of these relays should be falsely operated. Such a condition would interfere with the lock check feature for the register circuit relays, as described later, and would not otherwise be indicated. The HD relay locks through LSD or LSM normal to ground at PW1.

Operation of the register circuit release PRL relay, as described later, causes battery to be removed from the start lead from the register to the connector (SFD-B604). This ordinarily would release the register start relay and the pretranslator start relay in the connector, thereby causing the connection to break down. Since it is desired to make certain checks after the register release relay has been operated, the HD relay closes a supplementary battery to the HD lead to hold the connector start relays (SFD-B605). The HDK relay is provided to check this path and operates when it is closed.

To ensure adequate recycle time between calls, it is necessary for the pretranslator to take control of certain start grounds normally closed by the pretranslator connector circuit. For this purpose, the HD relay operated closes ground through TRL normal to the G1 and G2 leads to the connector (SFD-B605 and B608). These leads are bridged. Two leads and a series parallel contact arrangement are used because of the importance of this feature.

The grounds closed to the G1 and G2 leads, as previously mentioned, overlap and replace the start grounds normally closed by the connector. The HD relay operated also closes ground through TRB normal to the GR lead to the connector (SFD-B608). This causes a ground removal relay, designated GR, in the connector to operate and to disconnect the corresponding grounds originating in that circuit. Upon the release of the connection, this relay delays the reclosure of these grounds sufficiently to prevent false overlap between successive calls.

Upon operation of the GR relay in the connector, ground is connected to the PCK lead to the pretranslator, operating the PCK relay (SFD-B608). This closure indicates that all of the required control relays in the connector have operated to ensure transfer of connector control to the pretranslator.

B6-10.3 OPERATION OF REGISTER CIRCUIT RELEASE RELAY

Upon operation of the HDK relay (SFD-B605), indicating that the HD lead is properly closed, ground is connected to the PRL lead to the connector (SFD-B608) provided that the continuity check of the transmitting leads (SCD-B6-9.1) is satisfactory on calls requiring such leads. This path is traced from ground at normal contacts of the XR relay, through contacts of XT normal, HDK operated, TRB normal, CCM or BS operated, CSD or SW1 operated, HD operated, RLK normal, WT normal and TRTR normal to the PRL lead to the connector. The BS relay will have been operated if none of the CM leads are required, and the SW1 relay will have been operated if the SD lead is not required.

Ground connected to the PRL lead as above is closed through the connector to the register and operates the register circuit release relay PRL. This relay is double-wound. The PRL lead connects to one winding and the RLK lead to the other. When operated, it opens the start lead from the register to the connector (SFD-B604), it provides a locking ground for the register circuit (CM-) and (SD) relays (SFD-B607), and it locks through both of its windings, thereby returning ground to the pretranslator on the PRL and RLK leads (SFD-B608). Opening of the start lead has no effect as the start lead battery has previously been replaced by battery connected to the HD lead as described in SCD-B6-9.2. Ground connected to the RLK lead is closed through contacts of TRTR normal, RLK normal, TRB normal, and PCK operated to the winding of the RLK relay, causing it to operate. The RLK relay locks to ground on the RLK lead from the register and to ground on the PRL lead. It also closes a holding circuit for the TM relay (SFD-B608) to cause a timeout if ground should not be removed from the RLK or PRL lead, due to trouble, upon the release of the circuit.

B6-10.4 LOCK CHECK

Relay LCM (SFD-B607) is provided to check that the CM3, CMA, CMB, or CMC relay in the register circuit locks on calls requiring the operation of one of these relays. Relay LSD is provided to check that the SD relay in the register circuit locks, when it is required. If a CM relay and the SD relay are required, both relays BS and SW1 will be normal. The operation of RLK closes ground through normal contacts of BS, operating KTR. It also closes another path to operate KTR from ground through normal contacts of SW1.

Check transfer relay KTR operated as described disconnects the CM- lead from the winding of the CCM relay and connects it to the winding of the LCM relay. It also disconnects the SD lead from the winding of the CSD relay and connects it to the winding of the LSD relay. This causes CCM and CSD to release, if not previously released due to being shunted by the locking grounds for the register circuit relays. It also causes the LCM and LSD relays to operate from these grounds, thereby indicating that the associated register circuit relays have locked.

The minimum time interval (from the closure of ground from the XR relay normal through the winding of the CCM relay to a CM- lead, or from the closure of ground through the winding of the CSD relay to the SD lead, until these paths are opened by operation of the KTR relay) is greater than the maximum operate time of the register circuit CM- and SD relays, provided that the latter relays are properly adjusted.

If a CM- relay in the register circuit is required and the SD relay is not required, the operation of RLK closes ground through normal contacts of BS to operate KTR as described previously. This releases CCM and operates LCM, if the register circuit CM- relay has locked. Since SW1 relay would be operated in this case, RLK operates LSD directly.

If the SD relay is required and none of the CM- relays are required, RLK operates RTR through SW1 normal, thereby releasing CSD and operating LSD if the register circuit SD relay has locked. Since the BS relay would be operated in this case, RLK operates LCM directly.

If none of the above register circuit relays are required, the KTR relay does not operate as neither of its operating paths are closed, and the LCD and LCM relays are operated directly by the RLK relay through BS and SW1 relays operated.

From the foregoing it is evident that the BS relay operated cancels the continuity and lock checks which would otherwise be made in connection with a CM lead, and the SW1 relay cancels these checks for the SD lead.

In many of the above mentioned cases, the LCM relay operated locks to ground on the PW1 relay for a reason given later (SCD-B6-11). It also locks to ground on the RLK relay to prevent the breaking of current at the BS relay contacts, in case BS should release before RLK in disconnection. A lock* of these contacts would otherwise make the lock check feature inoperative without any indication thereof. The LSD relay locks to ground at the RLK to prevent the breaking of current at contacts of SW1 for the same reason.

* Repeated breaking of current by contacts on U-type relays causes a build up on one contact and a pit on the other. Occasionally the pit and build up will lock together holding the contacts permanently closed.

B6-11 RETURN TO NORMAL

With both LCM and LSD operated, parallel locking paths for the HD relay previously described are opened causing HD to release. Release of HD removes battery from the HD lead to the connector and releases HDK. It also removes ground from the G1, G2, and GR leads to the connector.

The removal of battery from the HD lead and the removal of ground from the G1 and G2 leads causes the connector circuit to release. These leads are opened simultaneously to prevent false starts in the connector which might otherwise occur if the HD lead were opened first.

Release of the connector opens the receiving leads thereby releasing any of relays AC-, BC-, CC-, LT, and 11X that were operated (SFD-B603) and causes release of the pretranslator as shown in the sequence chart SFD-B602.

Release of the connector also opens the PCK and MB leads releasing the PCK and MB relays. The MB relay released removes ground from the CB leads and connects ground to the TRS1 lead. Release of the receiving relays AC- etc. causes the operated translator relays, the operated BS or CM- relay, PW or SW, and PW1 or SW1 to release. Release of PW1 or SW1 releases LCM, thereby restoring the circuit to normal. The locking path for LCM to ground on the PW1 is provided to prevent false momentary operation of the HD relay during disconnection.

B6-12 ABANDONED CALL

The pretranslator is arranged to restore to normal at any state of a call if the originating register is released due to premature disconnection by the subscriber. Release of the register in this case removes ground from the receiving leads, releasing the operated AC-, BC-, CC-, LT and 11X relays. This in turn releases any operated translator relays and transmitting relays. If HD is operated, it is released due to the release of PW1 or SW1. This opens the HD, G1, and G2 leads. The connector restores to normal when these leads are opened, or due to the release of the register if they have not been closed. Release of the connector causes the pretranslator to restore to normal.

B6-13 TROUBLE CONDITIONS

CROSS-DETECTION

The XR relay operates if ground is connected to two or more of the BS- and CM- terminals (SFD-B607). Such a condition may be caused by crosses or locked contacts at the register or translator relays, or by external

trouble resulting in the connection of ground to three or more receiving leads for the A, B, or C digit, or to both of leads LT and 11.

A cross-condition which might cause both PW and SW relays to operate even though only one CM- or BS relay is operated causes both PW1 and SW1 relays to operate (SFD-B607). This removes the bias from the secondary winding of the XR relay causing it to operate even though there is current through only one CM- or BS relay.

Transmitting leads CM3, CMA, CMB, CMC, and SD are connected through normal contacts of relays CM3, CMA, CMB, CMC, and PW1, respectively, and through resistors to the winding of XT. Trouble release lead PTR is also connected to the XT relay through normal contacts of FA1, RLK, PRL, TR2, and TRB1 and through a resistor. A false ground on any of these leads with the circuit normal or on any lead not used during the progress of a call causes XT to operate. The resistors are provided to prevent backups which might cause additional false operations and would complicate the trouble record.

The operation of XR or XT opens the ground supply for the PRL lead (SFD-B608). This prevents the release of the circuit if a call is in progress in order that a trouble record may be taken and a second trial may be made if the call is a first trial call. To prevent registrations in the register in the event that XR operates, the ground feeding all the CM-leads from relay CCM (SFD-B607) is placed under control of the back contact of relay XR. To prevent a backup when relay TRB operates on second trials, a back contact of relay TRB is inserted in the PRL lead. Operation of XR or XT also operates relay TR, for taking the record as described later.

A false ground on the PRL lead with the circuit normal is closed through normal contacts of TRTR, WT, RLK, and HD, operating XRL (SFD-B608). A false ground on the RLK lead with the circuit normal is closed through normal contacts of TRTR, RLK, TRB, PCK, and HD operating XRL. Relay XRL operated operates TR.

Make-contacts of the HDK relay closes ground to the PRL lead (SFD-B608) and if they should lock, an open HD lead would not be detected.

Such a trouble, however, causes the TR relay to operate with the circuit normal, from ground through normal contacts of XR and XT, the locked contacts HDK, and normal contacts of TM, to the TR relay. Operation of the TR relay will start the TRTR timer which will time out to give an alarm and will hold the pretranslator out of service. This path is open while the PRL lead is being used on a call due to TM operated.

B6-14 TIMERS IN PRETRANSLATOR

B6-14.1 WORK TIMER (SFD-B611)

The work timer is started when the TM relay operates at the time the pretranslator is seized and continues timing until the TM relay releases upon release of the pretranslator or until it times out after 200 to 400 milliseconds. If the work timer times out, it operates the WT relay. The WT relay operates the TR relay (SFD-B608) which operates the TRST relay to initiate a request for a trouble record.

B6-14.2 TROUBLE RECORD TIMER (SFD-B611)

The TR relay (SFD-B608) is operated by the WT relay as a result of work timer timeout, by operation of the XRL, XR, or XT cross-detection relays or by falsely closed or locked HDK contacts when the TM relay is normal. As noted above, the TR relay operates the TRST relay to cause a trouble record to be taken. The TR relay also starts the trouble timer (SFD-B611) which times for 1.87 to 3.73 seconds which is long enough to allow for a trouble record to be taken under normal conditions. If the TRTR timer times out before the trouble record has been completed and caused the TR relay to release, the TRTR relay operates.

The TRTR relay operated locks from 130-volt battery through resistor TRT4, to ground at TR operated. TRTR opens the battery supply for the TRST lead so that the master test frame connector will be released if this has not already taken place. TRTR connects ground to the PRL and RLK leads (SFD-B608) to operate the register circuit release relay and at the same time connects battery to the HD lead (SFD-B605) to hold the connection even though the release relay in the register operates. TRTR also operates TRA (SFD-B611) which locks to ground on the AR lead from the miscellaneous circuit for all frames, connects ground to the TRT lead to that circuit to light a trouble time-out TRT lamp, and connects battery to the MJ lead to the alarm circuit to actuate a major alarm.

Relay TRA also opens the HD lead (SFD-B605). The control of the HD lead by TRTR and TRA is provided to ensure operating TRA before the connector releases. With the PRL and RLK leads grounded and the HD lead open the connector should release. However, a further alternate release path is provided by operating TRBA and TRL from TRA and TRTR. This provides for releasing the connector by control of the G1, G2, and GR leads as previously described.

The MB relay is held operated by relays TR, TRL, and TRB1 so that the circuit will be held busy if any of these relays should remain operated falsely due to trouble.

The TRA relay remains operated until ground is momentarily removed from the AR lead due to release of the alarm. If trouble records are called for during this interval, the TRB relay will operate from ground connected to the TRB lead by the TRA relay, and the master test frame connector will therefore appear to be busy.

B6-15 TROUBLE RECORD

B6-15.1 TROUBLE RECORD REQUEST

The TR relay operated as in any of the above cases (SCD-B6-13.2) closes ground to hold the MB relay (SFD-B611), it connects the TRB lead from the master test frame connector to the winding of the TRB relay, and it operates relay TRST. It also starts the trouble record timer TRTR. If the circuit releases after the trouble record is taken, or without a record if the master test frame connector is busy, the trouble timer is recycled without operating the TRTR relay. Its action upon failure of the circuit to release is described later.

If the master test frame connector is idle, as indicated by the absence of ground on the TRB lead, the TRB relay does not operate. Operation of the TRST consequently closes battery to the TRST lead to the master test frame connector circuit to operate the PPR relay of the MTFC to bid for preference to the trouble recorder.*

The TRST relay also closes a locking path for the TR2 relay which is operated on second trial calls and it connects ground on the LK lead from the master test frame connector circuit through normal contacts of TR2 to the MN lead to the jack, lamp, and key circuit or through operated contacts of TR2 to the MJ lead. This provides a minor alarm on first trial failure or a major alarm on second trial failure. The TRST relay also opens the operating path of the WT relay, to prevent it from operating if it has not already done so.

Due to closure of battery to the TRST lead, the master test frame connector advances and connects ground to the RCKK lead, operating relay RCKK as an indication that the call has received preference. This relay locks and connects ground to the CTM lead to the pretranslator connector, to cancel the time measure in that circuit (SFD-B611). This is done to prevent a connector time alarm due to the delay caused by taking a record.

* The PTA lead to the MTFC and the PTP- relays of the MTFC are used in establishing test calls to pretranslators and will be described in the maintenance section along with a more complete description of a trouble recorder.

Grounds connected to any of the A-, B-, C-, LT, and 11 receiving leads, the CM- and SD transmitting leads, and the PCK, PRL, RLK, PTR, TR2, and TRS control leads are forwarded to the master test frame connector circuit over multiples of these leads, for control of the interposer magnets in the trouble recorder. Ground is connected to the XX lead if relays XR, XT, or XRL are operated, or if contacts of HDK are crossed (SFD-B608). Ground at normal contacts of TR2 is connected to the TRK lead on first trial failures. The pretranslator connector also closes leads to the master test frame subgroup CN- and register RG- involved in the trouble.

Under certain conditions the CCM and CSD relays, if not already operated, may operate momentarily from battery through the trouble recorder interposer magnets, during the progress of the recording. This, however, will not cause the circuit to advance falsely.

If the continuity check feature is made ineffective for any reason such as crossed contacts of CCM or CSD relays or crosses at the contacts of BS or SW1 relays which parallel them, a continuity failure will appear as a lock check failure (SCD-B6-9.4). The appearance of a lock check failure will also be caused if the RLK lead becomes falsely grounded during a call, thereby causing the RLK and KTR relays to operate before the register circuit CM- and SD relays have operated. This also applies if the latter relays are out of adjustment and are extremely slow.

The LT lead is wired in all installations. The LT indication will be shown on trouble records in offices which do not have the LT and 11X relays equipped. In these offices the LT lead will be grounded on all calls.

B6-15.2 TROUBLE RECORD COMPLETE OR TROUBLE RECORDER BUSY

Upon completion of the trouble record or if the trouble recorder is busy at the time of a bid for the trouble recorder, the master test frame connector connects ground to the TRB lead, operating the TRB relay through operated contacts of TR (SFD-B609). The TRB relay opens the TRST lead which causes the master test frame connector to restore to normal, and it locks to relay TRST operated. It also opens the GR lead (SFD-B608) so that the pretranslator connector circuit GR relay may be released if a second trial is to be made, and it connects battery through the HD ballast lamp and TRL normal to the HD lead so that when the TRL relay operates, battery is removed from the HD lead at the same time that ground is removed from the G1 and G2 leads (SCD-B6-15.4) (SFD-B605). The TRB relay operates the TRB1 relay (SFD-B611) which puts ground on the TR lead to the master test frame plant register circuit provided the TR2 relay is normal indicating a first trial call. If the TR2 relay is operated indicating a second trial call, ground is put on the PST lead to the master test frame plant register circuit. Ground on the TR and PST leads is provided through a back- contact of a test relay PTT- in the master test frame connector. This is to prevent trouble

record registration on test calls. TRB1 also connects resistance battery to the PTP lead to the master test frame connector to prevent reestablishing the plant register ground on test calls before TRB1 releases. Grounds on the TR or PST lead will cause the plant register circuit to count the number of first and second trial troubles. Also on a second trial call the TR2 relay is locked operated through a contact of the TRB1 relay. Operation of the TRB1 relay also places ground on the MB lead to the pretranslator connector circuit to hold the pretranslator busy until TRB1 releases (SFD-B611).

B6-15.3 TROUBLE RELEASE AFTER A REQUEST FOR A TROUBLE RECORD

Upon completion of a trouble record or if the trouble recorder is busy at the time the trouble record is requested, the TRB and TRB1 relays operate. If the PTR has not progressed far enough to have operated the PRL relay of the OR (PRL and RLK relays normal in PTR) operation of the TRB1 relay grounds the trouble release lead PTR to the connector (SD-B607, B608).

Ground connected to the PTR lead is closed through contacts of the operated PCA- relay of the connector (SFD-B609) and through PTR1 normal, operating PTR. This ground is also closed to one side of the winding of PTR1. Relay PTR operated connects ground through the operated GC relay to the other side of the winding of PTR1, short-circuiting it so that it does not operate at this time and the PTR- relay also opens the locking path of the GR- relay, causing it to release if operated. Release of GR- recloses the G1 and G2 lead grounds to hold the PRA-, PRB, and GS relays (SFD-B604) so that the register connector and subgroup connector relays will remain operated after the pretranslator is disconnected.

The PTR relay operated operates TR2 of the PTRC (SFD-B611) which releases the PS relay (SFD-B604) by opening the STA, STB, and HD leads. This in turn releases the operated PC relay (SFD-B605), PA, PB, and PCA relays and the PK relay (SFD-B611), thereby disconnecting the pretranslator. Since the PC relay releases before the pretranslator removes ground from the CB leads, the associated CB relay (SFD-B605) operates. It locks to ground on the LCB lead unless all CB relays are operated. This causes a different pretranslator to be selected for the second trial, if one is available. Release of the PC relay also causes the Z relay to operate or release (SFD-B609) as previously described (SCD-B6-3).

When the PTR lead is opened by release of PCA, the PTR1 relay operates and the PTR relay locks in series. The PTR1 recloses the locking ground for the GR relays and releases TR2. The TR2 recloses the STA, STB, and HD leads (SFD-B605) which causes a pretranslator to be selected for second trial, the PS, PC, PA, PB, PCA, and PK relays operated as previously described. The TR2 is locked to W and Z if one of these relays is operated and the other released. This prevents reseizure of a pretranslator until Z has transferred the start lead preference. The TR2

relay is made slightly slow-release by the TR2 resistance so that the CB relay of the pretranslator which was just released will be operated before reselection of a pretranslator is attempted. The operated PTR1 relay grounds the TR2 lead (SFD-B611) to signal the newly seized pretranslator that this is a second trial.

B6-15.4 REGULAR RELEASE AFTER A REQUEST FOR A TROUBLE RECORD

If the pretranslator encounters trouble on a first trial call which has progressed far enough to operate the register circuit release relay, or on any second trial call, it does not connect ground to the PTR lead because one of the relays PRL, RLK, or TR2 will have been operated (SFD-B607). After the trouble record is taken, or if the trouble recorder is busy, it connects ground to the GR lead to operate the GR relay if it has not already been operated. On second trial calls, it also connects ground to the RLK lead to operate the register circuit release if it is normal (SFD-B608). The connector is then released in the regular manner due to the simultaneous opening of the HD, G1, and G2 leads by the pretranslator.

If the pretranslator encounters trouble on a first trial call which has progressed far enough to operate the PRL relay of the OR (as indicated by either or both the PRL and RLK relay operated in the PTR) the PTR lead is not grounded (SFD-B607). The PTR lead is not grounded on any second trial call because of the operated TR2 relay.

Under the above conditions, upon completion of a trouble record or if the trouble recorder is busy, the TRB relay operates (SFD-B611) and in turn operates the TRB1 and TRBA relays. On second trial calls operation of the TRB relay also ground the RLK lead from ground on the TRL relay normal to operate the PRL relay or the OR if it has not already been operated.

The TRBA relay connects ground to the G1, G2, and GR leads (SFD-B608) to operate the GR relay of the PTRC which opens grounds to the G1 and G2 leads from the PTRC thus transferring control to the pretranslator. The TRB1 relay is a slow-acting relay so that there is a slight delay from the time that the TRB relay operates until the TRBA and TRB1 relays operate the TRL relay (SFD-B611). When the TRL relay operates, it removes ground from the G1 and G2 leads and on second trial calls from the RLK lead (SFD-B608). The operation of the TRL relay also opens battery to the HD lead (SFD-B605). This simultaneously releases the PRS and PS relays of the PTRC via the HD lead along with the PRA, PRB, and GS relays via the G1 and G2 leads. This in turn releases other connector relays (SFD-B604, B605, B609). Upon release of the connector relays, all operated relays of the PTR release.

B6-15.5 CALL ABANDONED WHILE TROUBLE RECORD IS BEING TAKEN

If the subscriber disconnects while a trouble record is being taken, the pretranslator restores to normal as described in SCD-B6-11, thereby releasing the relays operated because of the trouble condition. The consequent removal of battery from the TRST lead causes the master test frame connector to restore to normal. A partial trouble record will result.

B6-15.6 MASTER TEST FRAME CONNECTOR BUSY

If the master test frame connector is busy when a trouble record is called for, ground on the TRB lead operates relay TRB upon operation of TR relay (SFD-B611). This prevents the closure of battery to the TRST lead to the master test frame connector circuit. The RCCK relay does not operate. Upon operation of TRB, the DL relay operates. The DL relay locks and connects ground to the DL lead to the jack, lamp, and key circuit to light a display lost lamp (DL). This relay remains operated until battery is momentarily removed from the DLB lead by the JLK circuit.

The TRB relay opens the GR lead (SFD-B608) and connects battery to the HD lead independently on the HD relay (SFD-B605) as previously described, and causes the operations described in SCD-B6-14.2 to take place.

B6-16 TEST CALLS

The pretranslator may be tested from the master test control circuit over paths closed by the master test frame connector circuit. The operation of the circuit on test calls is as previously described for regular calls, except that the PS and PC relay (SFD-B605) do not release. The receiving lead grounds and other incoming signals to the pretranslator are provided by the master test control circuit, and the outgoing signals are returned to it to light lamps at the MTC. The pretranslator connector is not involved in these calls.

If a test call is started while the pretranslator is busy on a service call, the test connection is delayed until the service call is completed. The busy condition in this case is indicated by ground on the TM lead to the master test frame connector circuit.

B6-16.1 SELECTION OF PRETRANSLATOR AND CONNECTION TO PRETRANSLATOR VIA MTFC

Selection of a pretranslator and connection to it via the MTFC will be described in the maintenance section.

B6-16.2 SIGNAL TO OPERATE KEY CONNECTING RELAYS

Ground on the TS lead from the master test frame connector operates the TS relay which operates the PC1 relay through previously operated PT1 and SR relays (SFD-B608). The PC1 relay:

- (a) Operates KA, KB, and KC relays to closed through the A, B, and C key or switch contacts (SFD-B603).
- (b) Operates PC2 relay and, if OT and PTR keys are normal, operates the PC3 relay (SFD-B608).
- (c) Locks around contacts of the SR relay.

Relays PC1, PC2, and PC3 are connecting relays which close through leads via the master test frame connector to the pretranslator and also furnish grounds to the TR2/TRS key and to the 11 key or the TRNA switch (SFD-B603) which control the grounds applied to the TR2, TRS LT, and 11 leads.

B6-16.3 REGULAR PRETRANSLATOR TEST

When the pretranslator receives a code and a ground on the LT or the 11 lead and has translated the code accordingly, it returns ground on one or more of the transmitting leads SD, CM3, CMA, CMB, or CMC through low-resistance continuity check relays (SFD-B607). These grounds operate corresponding relays of the test circuit and light lamps.

When the pretranslator has completed its translation, it operates its HD relay (SFD-B608) which grounds GR and G1T leads and closes battery through its low-resistance HDK relay to the HD lead. The PST relay of the test circuit, having been operated from resistance battery, extends this battery and ground through its winding to the HD lead. The HDK relay of the pretranslator operates to ground (SFD-B605) and the GR and G1 relay of the test circuit also operate (SFD-B608).

Upon operation of the HDK relay, if the pretranslator has been satisfied on its continuity checks of the transmitting leads, it grounds the PRL lead. The PRL lead is closed through the test circuit relays PST, GR, and G1 operated, to operate the PRL relay. The PRL relay locks on both windings and extends ground back to the RLK lead, lights the PRL lamp, provides locking ground for the SD, CM3, CMA, CMB, and CMC relays (SFD-B607), and opens the operate circuit of the PST relay which holds to the HD lead (SFD-B608).

Upon receiving ground on the RLK lead, the pretranslator checks that there is now locking ground on the transmitting leads which it had previously grounded (SFD-B607) (SCD-B6-9).

If the lock check is satisfactory, the HD relay of the pretranslator releases, opening the G1T, GR, and HD lead to release G1, GR, and PST relays of the test circuit which closes a path through the PRL relay operated to operate the MFC relay which in turn operates MFC1 relay to release the MTFC (to be covered in maintenance section). When the master test frame connector has restored to normal, it releases the TS relay.

The PTT, PTR, and those lamps of the CM3, SD, CMA, CMB, and CMC group corresponding to the translation remain lighted at the end of the test.

The G1 and GR lamps flash momentarily but are extinguished at the end of the test.

Operation of the RL key operates the KR and KR1 relays which remove locking grounds allowing the release of the circuit.

B6-16.4 CHECK THAT PRETRANSLATOR APPLIES AND REMOVES GROUND ON GR AND G1 LEADS

The slow-release SR relay is operated through back-contacts of the G1, GR, and PTR1 relays when the PST relay operates. Since the PC1 relay is operated through a make-contact of the SR relay, a check is made that SR is operated before the test starts (SFD-B608).

When the HD relay of the pretranslator operates, it should apply ground to both GR and G1T leads. If either GR or G1 relays fail to operate, the operate path for the PRL relay is held open and the SR relay starts to release. Release of the SR extends locking ground for PST, GR, and G1 relays to hold whichever are operated and also operates MFC relay to release the connection. It is possible that the work timer of the pretranslator might time out to cause a partial record before the SR relay releases under this condition.

The PTT, HD, and either GR or G1 lamps should remain lighted at the end of the test.

If, on an otherwise satisfactory call one or two of the G1T, GR, and HD leads are opened but not all, the MFC relay is prevented from operating until the SR relay releases. When the SR has released, it provides locking circuits for G1, GR, and PST relays to hold up whichever are operated and operates the MFC relay to release the connection. It is possible that the pretranslator may time out and take a partial record before the SR releases under these conditions.

At the end of the test, the PRL, proper SD, CM3, CMA, CMB, and CMC lamps and one or two of the HD, GR, or G1 lamps remain lighted.

B6-16.5 OPEN PRL LEAD - PRL KEY

Operating the PRL key (SFD-B608) opens the PRL lead. When the pretranslator advances to the point of grounding the PRL lead, it blocks because it does not receive ground back on the RLK lead and takes a trouble record which should indicate NO RLK. Upon completion of the trouble record, the pretranslator, having determined that neither the PRL nor RLK leads are grounded, grounds the PTR trouble release lead unless it is handling a second trial call (TR2 key operated). Ground on the PTR lead operates PTR1 relay of the test circuit which starts release of slow-release SR relay and opens the operate path of the PST relay. The pretranslator should maintain battery on the HD lead and ground on the G1T lead but should open the GR lead. The SR relay, being slow, allows time for the PST, GR, and G1 relays to release before closing locking circuits. Upon release of the SR relay, the MFC operates to release the test connection.

The HD, G1, and PTR lamps should remain lighted at the completion of the test. The GR lamp should not be lighted. Some of the SD, CM3, CMA, and CMB or CMC lamps may have lighted during the test but will not remain lighted at the completion of the test because the PRL relay will not have operated to lock them in (SFD-B607).

If the TR2 key (SFD-B611) is operated to simulate second trial, the pretranslator, upon completion of the trouble record, grounds the RLK lead during the operate time of the TRBA and TRL relays of the pretranslator (SFD-B608). The GR lead is opened momentarily then reclosed, and the HD and G1T leads are then opened. Upon operation of the PRL relay of the test circuit over the RLK lead, the SR relay starts to release. Release of the SR relay operates the MFC relay to release the connection and provides a locking circuit for the GR relay.

At the end of the test the PRL, GR, and the proper SD, CM3, CMA, CMB, and CMC lamps should remain lighted.

If the TR2 and RLK keys are operated in addition to the PRL key to simulate second trial failure with both PRL and RLK leads open, the test proceeds as described previously except that the PRL relay does not operate. The SR relay starts to release when the HD and G1 relays release.

At the end of the test the GR, and the proper SD, CM3, CMA, CMB, and CMC lamps should remain lighted.

B6-16.6 OPEN RLK LEAD - RLK KEY

Operating the RLK key (SFD-B608) opens the RLK lead. When the pretranslator advances to the point of grounding the PRL lead, the PRL relay operates but because it cannot return ground on the RLK lead, the

pretranslator blocks and takes a trouble record. Upon completion of the trouble record, operation of the TRB relay of the PTR (SFD-B611) removes ground from the GR lead (SFD-B608). Because there is ground on the PRL lead, the PRL relay of the PTR operates. The TRBA relay of the PTR (SFD-B611) is then operated. The TRBA relay recloses ground to the GR lead and operates the TRL relay which removes ground from the G1T lead. The PTR lead is not grounded. The PST and G1 relays release, starting release of the SR relay. The SR provides a locking circuit for the GR relay.

The PRL, GR, and the proper SD, CM3, CMA, CMB, and CMC lamps should remain lighted at the end of the test. The test should be the same whether the TR2 key is operated or normal.

B6-16.7 OPEN TRANSMITTING LEADS - OT KEY

Operating the OT key prevents the operation of the PC3 relay (SFD-B608) which is the connecting relay for the transmitting leads (SFD-B607). For any code having a translation which would ground one of the transmitting leads (SD, CM3, CMA, CMB, and CMC), the pretranslator will not detect battery on that lead, will recognize a continuity failure, and will take a trouble record.

With the OT key operated, the test functions, after the trouble record, as previously described for PRL key. The lamps SD, CM3, CMA, CMB, or CMC will not be lighted.

B6-16.8 FAILURE TO RECEIVE LOCKING GROUND ON TRANSMITTING LEADS - LK KEY

Operating the LK key prevents locking any of the relays SD, CM3, CMA, CMB, or CMC. On codes having other than the basic translation; i.e., having translations which require grounding some of the transmitting leads, the pretranslator blocks when it does not detect locking ground returned on those leads, and takes a trouble record. Upon completion of the record, the pretranslator momentarily opens the GR lead, then having detected ground on the PRL and RLK leads, recloses the GR lead and opens the HD and G1T leads. The PST and G1 relays releasing start the release of the SR relay. The SR relay releasing locks the GR relay and operates the MFC relay to release the connection.

The PRL and GR lamps should remain lighted upon completion of the test. The proper SD, CM3, CMA, CMB, or CMC lamps will light momentarily but will not remain lighted. The test functions the same with TR2 key operated or normal.

B6-16.9 OPEN PTR LEAD - PTR KEY

For this test the TR2 key should be normal and a code having other than a basic translation should be used. One test should be made with the PRL key operated and another with RLK key operated to test that the pretranslator grounds both RLK and PRL leads.

Operating the PTR key opens the PTR lead and also opens the operate path of the PC3 relay to produce an open transmitting lead condition. When the pretranslator detects this condition, it takes a trouble record, opens the GR lead, and grounds the PTR lead.

The PTR1 relay does not operate, however, because the PTR lead is open. The pretranslator times out on its TRTR timer, brings in an alarm on the pretranslator frame, and grounds the PRL, RLK, and GR leads and then opens HD, G1T, PRL, and RLK leads. The PRL and GR relays should operate. The PST and G1 relay should release. Release of the PST or G1 relays starts release of the SR relay which operates the MFC relay to release the connection. A make-contact of the PTR key prevents release of the SR relay upon release of the GR relay.

At the completion of the test, the GR and PRL lamps should be lighted and there should be an alarm at the pretranslator frame.

B6-16.10 CROSSED OR OPEN RECEIVING LEADS

An older test frame having pushbutton A, B, and C keys, by operating more than one button on the A, B, or C keys, more than 2/5 receiving leads are grounded. If the translations of the code combinations are the same, the pretranslator will detect no trouble and will return the correct translation to the test frame. If, however, the translations of the code are different, the pretranslator will detect the cross and take a trouble record, indicating an XX punch and showing which receiving leads are grounded.

To produce a condition giving the maximum resistance path which is normally expected to operate the crossed-receiving lead detection relay, a combination of buttons on the C key (or the 2CD key with the C switch) should be operated to produce codes having translations which ground only two of the cross-connection points BS, CMP3, CMPB, and CMPC or only two of the cross-connection points BS, CMS3, CMSA, CMSB, and CMSC in the pretranslator.

The C leads grounded by C switch with 2CD key operated are shown in Table F.

TABLE F

Position	Normally Grounded	Extra Lead Grounded With 2CD Key Operated
0	4,7	1
1	0,1	4
2	0,2	4
3	1,2	7
4	0,4	7
5	1,4	0
6	2,4	0
7	0,7	2
8	1,7	2
9	2,7	1

If no button is operated on one of the A, B, or C keys or if one of the A, B, or C switches is in the OFF position (so that an incomplete code is received,) the pretranslator will time out and take a trouble record showing the data received.

B6-16.11 TRANSFER START - TRS KEY

Operating the TRS key simulates a connector transfer start condition by grounding the TRS lead. The pretranslator functions as it would otherwise except that it takes a trouble record before opening the HD and GLT leads, causing the GR lamp to remain lighted. In service this record would show the pretranslator connector used, but this information is lacking on a test call because no pretranslator connector is used.

B6-17 PRETRANSLATOR TROUBLE RECORD CARD ANALYSIS

If it is determined from the trouble analysis flowcharts in SFD-A5 that a trouble record card was produced by a pretranslator, see the pretranslator sequence chart (SFD-B602).

Since the translator job performed by a pretranslator is simple by comparison with the job performed by a marker, analyzation of trouble is much less complex. Designations which may be perforated on the card are listed on the following page.

TI	Trouble detected by pretranslator
MTPT	Pretranslator test call
SRT	Originating register test call
PRT	Pretranslator trouble record
DR-	Pretranslator Number
FR-	Frame
CN-	Connector
RG-	Register
ITR or TRK	1st trial
2TR or TR2	2nd trial
A-	
B-	Input digits to pretranslator
C-	
LT	Local Translator
11	Foreign Area Translator
CM3/CMA/CMB/	Output from pretranslator
CMC/-SD/-	
PCK	Connector control transferred to pretranslator
XX	Cross-condition detected
PRL	Release signal to originating register
RLK	Release Check
PTR	Pretranslator trouble release signal to connector.

B6-17.1 CROSS-DETECTION, XX PUNCH

If the XX indication is punched, there is generally not too much that can be determined from the card directly as a clue to what is crossed. A test call using the same input information to the pretranslator should be set up (SFD-B714). If there is a trouble in the pretranslator it should produce cards similar to the one produced in service. If pretranslator tests do not cause the pretranslator to fail, the trouble may be in the connector or originating register. An OR class of test using the ABC code shown on the trouble record should be set up (SFD-B712) during a period when traffic load will permit all pretranslators made busy but the one which produced the trouble card. This will use all the same circuitry used on the call which produced the trouble record. If the call fails on test calls, it is usually necessary to run repeated tests and to observe relay operation such as XT, XR, XRL, and TM to determine which type of cross was detected to cause the XX punch (SFD-B608).

B6-17.2 TROUBLE RECORDS OTHER THAN XX

For trouble records other than those having an XX punch, verify that there is an LT or 11 punch. The A, B, and C digits should be punched. Observe that there are two and only two punches in each. Where 11 is

punched, there may be only the A digit in some cases. Verify from office records that the proper output designations are punched. There may or may not be a PRL or RLK punch depending on how far the pretranslator progressed before the trouble record was produced.

A frequent cause of pretranslator trouble records is from mutilated digits in the originating register (more or less than two leads grounded in the A, B, or C digits). The majority of such trouble is caused by outside plant conditions or by customer dialing habits (SCD-B5-2.2, B5-2.11); however, crossed leads in the OR or the PRTC or fault adjustment of relays in the OR may also cause mutilated digits.

As described in SCD-B6-17.1, PTR test calls or OR test calls should be set up to locate and clear trouble indicated by the trouble record.

SECTION B, PART 7

MAINTENANCE

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B7 MAINTENANCE

This part of the B section covers some of the aspects of the use of the master test frame to detect, locate, and clear trouble.

B7-1 USE OF THE MASTER TEST CONTROL TO SIMULATE CALLS WHICH PRODUCE TROUBLE RECORDS

Analysis of trouble record cards using the trouble analysis chart and sequence charts of part B0 localizes the trouble to an area which may involve a path through one or two relay contacts within one circuit or may involve a path through many relay contacts in several circuits. Generally, it is impossible to troubleshoot the path on a static basis. The contacts which close to establish the path are often closed for only a fraction of a second during marker holding time. Frequently, the path which produced the failure is used only when a particular configuration of circuits or network paths is used. For this reason, it is desirable to be able to reproduce the same condition which caused the trouble in the beginning. The master test control circuit provides the means for such controlled simulation of actual calls without affecting service.

B7-2 USE OF SIMULATION TABLES AND ILLUSTRATED TROUBLE RECORD CARDS

The purpose of simulation tables in SFD-B702, B704, B706, B714, B716 and B718 is to correlate trouble record card designations with the key(s) or switch(es) of the master test control frame, which should be operated to provide input or control to the dial tone marker or pretranslator when simulating a trouble record card. Included, for easier reference, is a trouble card designation location for different types of trouble cards. The three types of trouble record cards illustrated are E-5488 (2/X double-sided shown on SFD-B703 and B715, E-4393 (1/X double-sided) shown on SFD-B705 and B717, and E-3638 (1/X single-sided) shown on SFD-B707 and B719.

The drawings in SFD-B703, B705, B707, B715, B717, and B719 depict a trouble record card which includes all of the possible designations (colored) which might be perforated on a record produced by DT (dial tone) or PRT (pretranslator) type call. A color key arrangement is used to indicate the different functions of designations regarding dial tone marker or pretranslator input or output information, progress of call, circuits or paths used, etc.

B7-2.1 FUNCTIONS OF DIAL TONE CLASS OF CALL (DT)

One of the tables on SFD-B702, B704 or B706 and the associated colored trouble record card which corresponds to the type of trouble record card being analyzed should be used. The tables are divided into two parts. The left-hand side of the chart shows functions used, designations perforated, and the designation location on a particular trouble record card. The right-hand side of the chart lists the different key(s) or switch(es) used to simulate trouble record indications, depending on the type of master test control frame provided. The following is a brief description of the key and switch arrangements and their relationship to the trouble designation for each of the functions listed in above tables.

- (a) To select the dial tone class of marker test, the DT key must be operated or if provided, the TSTA switch must be set to position DT.
- (b) Select the particular DTM which produced the record.
- (c) Set up the same line location indicated by the card.
- (d) In some of the older offices, class-of-service keys are not effective on DT class of test. The class-of-service keys are effective on DT class of test as a standard feature in new (or updated) offices and offices arranged for 60 classes of service. In general, class-of-service keys should not be operated on DT class of test. With class-of-service keys normal, the DTM determines class of service from cross-connections in the line link frame associated with the line location. If class-of-service keys are operated (in offices where they are effective), the class-of-service keys simulate and bypass the class-of-service cross-connections in the line link frame. In offices having 60 classes of service, the CGA and CGB cross-connections of the line link frame cannot be tested or verified. A test trouble card will always show a CGA punch if the CGB key is normal or a CGB punch if the CGB key is operated as long as either the CGA or CGB cross-connection is provided.
- (e) Set up the same rate treatment, if provided, as indicated by the trouble record card.
- (f) With the FS/NTFS key normal, the DTM selects a trunk link frame in the same manner that it would on a service call. By operating the FS key along with the FG(0-2) and an FS(0-9) key or the FS(0-9) switch,

the DTM selects a marker in the normal manner but is restricted to selecting only that trunk link frame corresponding to the operated FS(0-9) key or switch. Ordinarily the NTFS key should not be used on a DT class of test since it causes the marker to operate in an abnormal manner for trunk link frame selection.

- (g) With the TS/NTTS key normal, the DTM selects an OR in the normal manner. With the TS key operated along with the TS0-9 key or the TSU0-9 switch, the DTM selects an OR in the normal manner but is restricted to selecting only that OR corresponding to the operated TS0-9 key or the setting of the TSU switch. Ordinarily the NTTS key should not be used on a DT class of test since it causes the marker to operate in an abnormal manner for originating register selection.*
- (h) Refer to table in SCD-B1-5.7 for operation of keys or switches to control register group selection and to test associated cross-connections.
- (i) A particular path through the network from a line in a particular horizontal group on a line link frame to a trunk on a particular trunk switch of a trunk link frame is defined by channel number and junctor group.
 - (1) Operation of a CH0-9 key or the CH0-9 switch will direct the DTM to select that channel number.
 - (2) Selection of a particular junctor group is not as straightforward as it seems. Reference should be made to the chart on SFD-B708 to select the horizontal line of the chart corresponding to the size of office. Note that the same junctor group may be selected in 2 or more junctor sequence positions and is dependent on junctor step position 1 or 2.
 - (3) The trouble card will show the junctor group and junctor step position. Junctor step position may be selected by operating the STP1/STP2 key.

* If the OR to be selected is made busy, the NTFS and NTTS keys should be used to permit selection of the OR. It should be recognized, however, that this does not test normal trunk link frame and OR selection.

- (4) The JSQ (0-5) key or switch should be operated to select a junctor sequence position which associates with the junctor group for the junctor step selected. In some cases, the JSQ (0-5) key or switch might be set in any of several positions to select the desired junctor group.

- (j) With OBS key normal, a nonobserved call is simulated, operating the OBS key which simulates an observed call.

B7-2.2 FUNCTIONS OF PRETRANSLATOR CLASS OF CALL (PRT)

Use one of the tables on SFD-B714, B716 or B718 and the associated colored trouble record card which corresponds to the type of trouble record card being analyzed. The tables are divided into two parts. The left-hand side of the chart shows functions used, designations perforated, and the designation location on a particular trouble record card. The right-hand side of the chart lists the different key(s) or switch(es) used to simulate trouble record indications depending on the type of master test control frame provided. The following is a brief description of the key and switch arrangements and their relationship to the trouble designation for each of the functions listed in the above tables.

- (a) To select the pretranslator class of test, the PTT key must be operated, if provided, or the TSTA switch must be set to position PTT.
- (b) Select the particular PRT which produced the trouble record. The selection is made by the operation of the MT key or MTU switch. This key or switch is also used for the selection of markers and transverters.
- (c) Set up translation (LT or 11) as indicated by trouble record.
- (d) Set A through C digits with a known good office code.

B7-3 USE OF CLASS-OF-TEST TABLES

The class-of-test tables shown on SFD-B710 through B713 and B720 summarizes, in tabular form, the key(s) and switch(es) used to establish the particular class of test. A single line is used to separate a particular function with its associated figure, option, key or switch. The double line within the single lines is used to separate the various options or vintages of master test control frames. The note column and sheet notes are as follows:

- (a) Note 1 indicates that all key(s) or switch(es) must be operated to make a proper test frame setup for the particular class of test. It is suggested that known working equipment be selected for test.
- (b) Note 2 indicates the key(s) or switch(es) to be operated to simulate the trouble record. Refer to simulation tables in SFD-B702, B704, B706, B714, B716 or B718 and their associated colored trouble record card on the opposite page of the simulated table selected. The tables and colored trouble record cards, along with the class-of-test tables, will assist the maintenance personnel in selecting the proper key(s) or switch(es) to be operated in order to properly simulate the reported trouble condition.
- (c) Note 3 indicates those key(s) or switch(es) used for additional marker tests but they are not necessarily required for trouble record test or simulation test.

B7-3.1 DIAL TONE CLASS OF TEST

The SFD-B710 and B711 summarize, in tabular form, the key(s) and switch(es) used to establish a dial tone class of test and to perform certain specific dial tone marker tests.

On a dial tone class-of-marker test the master test control circuit simulates a line on a line link frame and a line link connector. The marker is primed with the line equipment location and other information which it would normally receive from these simulated circuits. The marker then proceeds to seize an originating register as it would in processing a service call.

When the connection is established, the marker and all established linkages release. However, information regarding the test is locked in the master test control circuit in the form of operated relays or lighted lamps under control of the RL key. If the REC key is operated, a trouble record is taken just prior to the release of the marker.

B7-3.2 ORIGINATING REGISTER CLASS OF TEST

The SFD-B712 and B713 summarize, in tabular form, the key(s) and switch(es) used to establish an originating register class of test.

Regular test calls of originating registers are usually made by using the originating test line as the calling line. On this type of test, the master test control circuit extends the originating test line to the monitor where subscriber line and dialing conditions are simulated. The test connections are set up by the marker under control of the master

test control circuit. The key(s) or switch(es) of the master test control circuit are operated to select the marker to establish the test connection, to set up the called number to be sent to the register, to set up the class of service of the calling line, to select the trunk link frame location of the desired register, and to select the desired register.

The keys of the monitor are operated to prepare the circuit for a test, to set up the speed of pulsing, and to establish the calling subscriber line condition which matches the class of service set up on the master test control circuit.

B7-3.3 PRETRANSLATOR CLASS OF TEST

The SFD-B721 summarizes, in tabular form, the key(s) and switch(es) used to establish a pretranslator class of test.

Pretranslator tests are made by seizing the pretranslator directly from the master test control circuit. The office code to be translated by the pretranslator is set up on the A-, B-, and C- key(s) or switch(es) of the master test control circuit. The master test control circuit simulates an originating register and passes the information to the pretranslator by way of the master test frame connector, which now simulates a pretranslator connector. The pretranslator under test translates the code received and transmits information to the master test control circuit. The translated information indicates the number of digits the OR should receive, if station delay is required, and if the OR should wait before grounding a start lead to seize a completing marker. This information is displayed on the pretranslator test lamp on the master test control panel. The test circuit also simulates various trouble conditions to make tests of the pretranslator checking features.